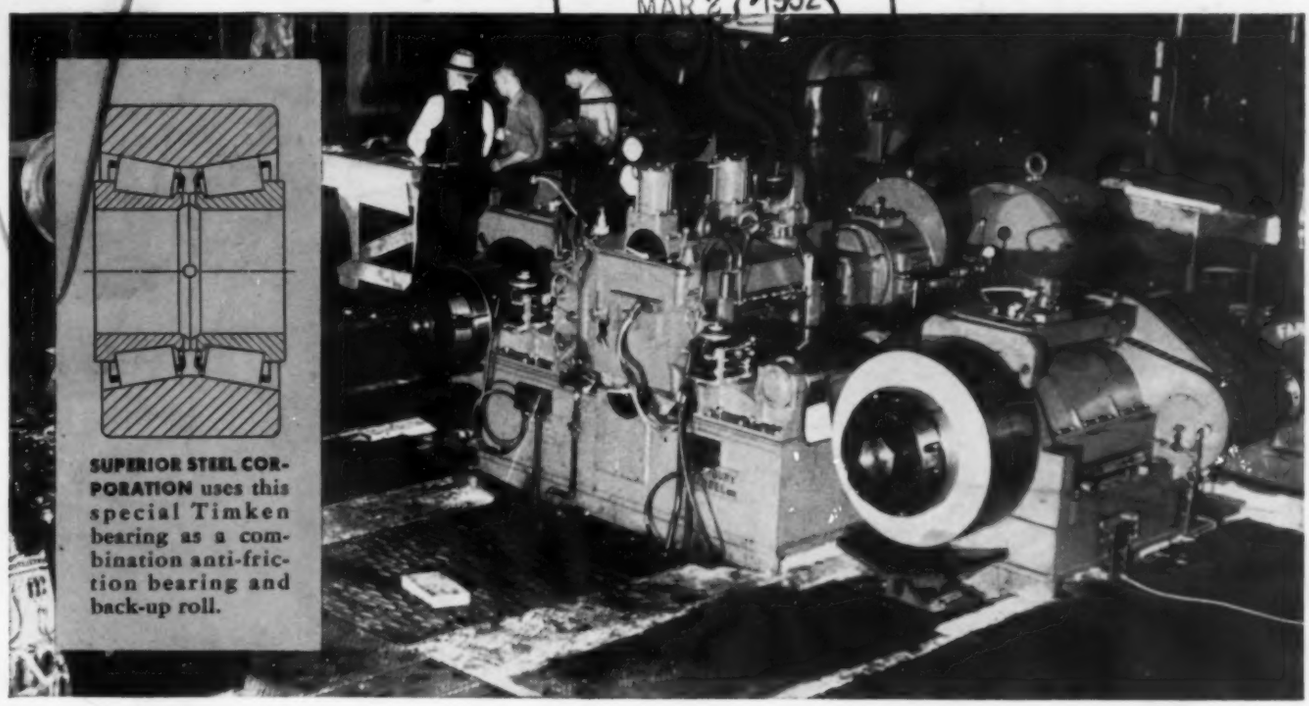
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MARCH, 1952

TECHNOLOGY DEPT.
PUBLIC LIBRARY
MAR 27 1952

TABLE OF CONTENTS, Page 53



SUPERIOR STEEL CORPORATION uses this special Timken bearing as a combination anti-friction bearing and back-up roll.

Less scuffing and scoring in Sendzimer mill with TIMKEN® bearings as back-up rolls

THE Superior Steel Corporation has a total of 54 Timken® tapered roller bearings as back-up rolls in their Sendzimer mill which is used for the cold reduction of high tensile and stainless steels. The Timken bearings used in this application are of a special design in which the outer race of the bearing is the back-up roll.

Timken bearings as back-up rolls reduce end-movement. Thrust washers are unnecessary. Due to the tapered construction of rollers and races, Timken bearings carry both radial and thrust loads in any combination. The O.D. of the outer race has a surface finish of fifteen micro-inches. As a result, scuffing and scoring of the back-up rolls and associated rolls are minimized—and there's less chance of marking the high quality finish stainless steel strip.

The incredibly smooth surface finish and true rolling motion of Timken bearings practically eliminate friction. What's more, Timken bearings provide extra load-carrying capacity due to line contact between rollers and races.

The extra heavy races of the Timken bearings in this application give maximum support. Since they are the back-up rolls, they simplify design.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →○← LOADS OR ANY COMBINATION ✳

what are the FACTS ABOUT SAFETY SWITCHES?

1 IS "INTERNAL HEATING" IN SAFETY SWITCHES IMPORTANT?

Engineering research fully authenticated by outstanding authorities shows "internal heating" in Safety Switches to be the principal cause of Safety Switch failures.

2 HOW DOES "INTERNAL HEATING" CAUSE SAFETY SWITCH FAILURES?

By literally baking the life out of Safety Switch parts. It causes insulating materials to disintegrate, metal parts to warp and corrode, so switches either become inoperative or "burn up" through inability to carry the load.

3 WHAT CAUSES "INTERNAL HEATING" IN SAFETY SWITCHES?

In properly constructed Safety Switches, fuses are responsible almost exclusively for "internal heating." This is no criticism of fuses; it is unavoidable. Any fuse carrying its rated load *must* be near its melting point if it is to perform properly when an overload occurs. Any metal operating *near* its melting point must be *hot* and fuse links *are* hot, with temperatures running as high as 700 degrees Fahrenheit.

4 HOW CAN THE TROUBLE FROM "INTERNAL HEATING" BE OVERCOME?

As the adequate enclosure so fundamental to *safety* in Safety Switches makes thorough venting of the trapped heated air impossible, the only escape from the ravages of "internal heating" can come through selecting materials for the internal structure and designing this structure to successfully withstand the unavoidable heat conditions to be met in service.

5 WHAT SAFETY SWITCHES AVOID "INTERNAL HEATING" TROUBLES?

Cutler-Hammer Safety Switches avoid these troubles. They were completely redesigned over *ten years* ago to beat "internal heating" when engineering research clearly indicated the need for *such* Safety Switches. *Years* of experience now prove the Cutler-Hammer claim of better Safety Switch performance far more than a mere promise; it is a proven *fact*. Ask the men who use them. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 3

50 years of creative engineering
SEAMLESS TUBE MILLS
PIERCING MILLS · PLUG MILLS
CONTINUOUS TUBE ROLLING MILLS
CONTINUOUS BUTT WELD PIPE MILLS
DRAWBENCHES FOR FERROUS AND NON-FERROUS BARS AND TUBES
REDUCING MILLS · SIZING MILLS · LEVELLERS
CONTINUOUS CUTTING LINES · REELERS
SLITTING LINES · SHEAR LINES
WIRE DRAWING EQUIPMENT

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.

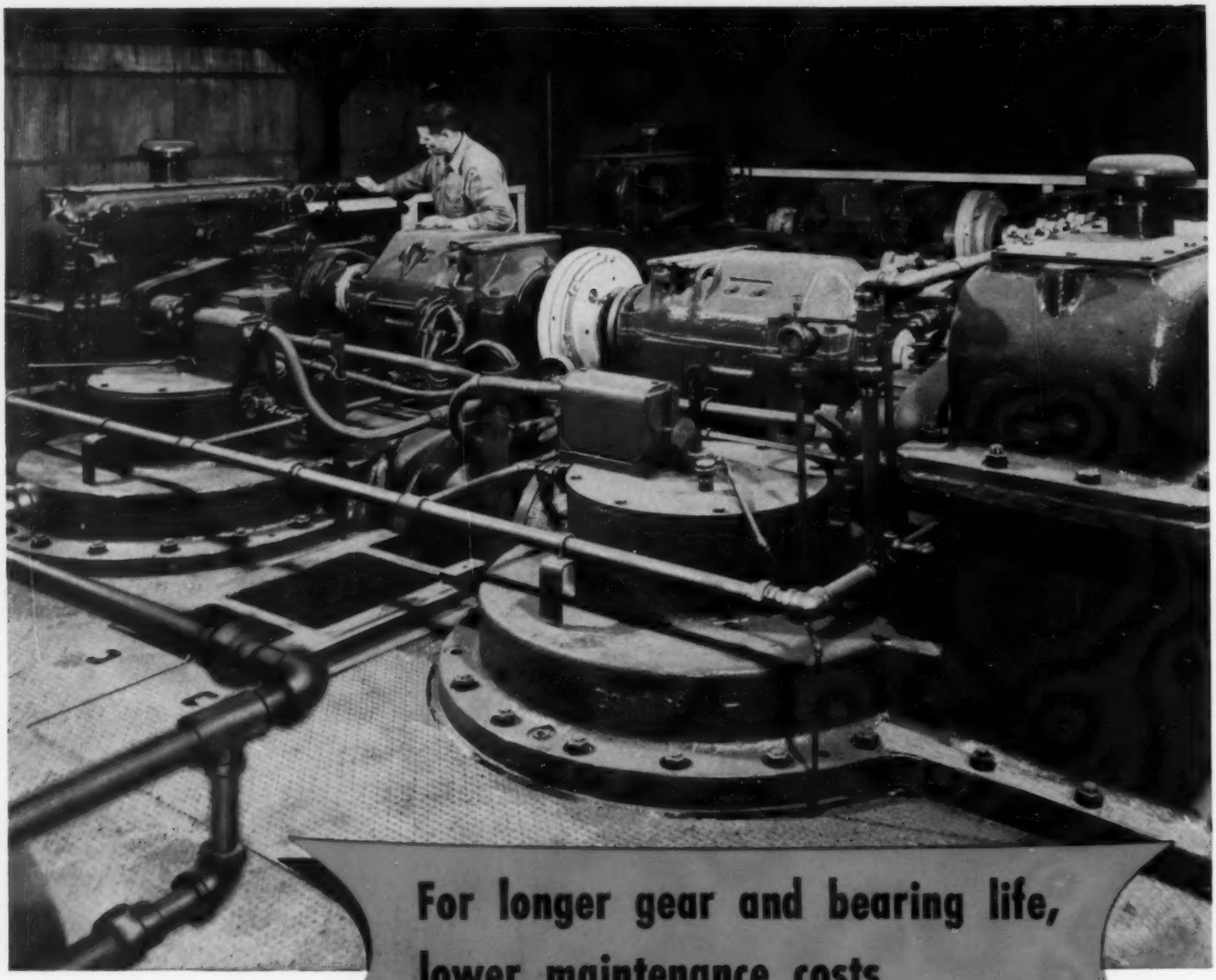
Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

Aetna-Standard

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania



---GULF E.P. LUBRICANTS

Gulf E. P. Lubricants have proven ability to protect gear teeth against overloads and shock loads in steel mill pinion stands, gear drives, screw downs, and table drives. Here's why!

They are specially compounded to prevent metal-to-metal contact and excessive tooth wear under extreme pressures. Because of their higher film strength, you get extra protection against gear troubles when production demands approach or exceed the rated capacity of equipment. And they are equally suitable for the lubrication of all types of bearings. This kind of protection means longer gear and bearing life—lower maintenance costs.

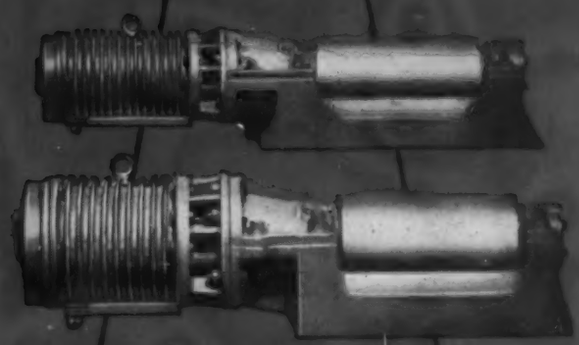
Gulf E. P. Lubricants have many other qualities, too, that insure trouble-free gear-drive performance. They have, for this type of lubricant, oustanding ability to separate quickly from water, an exceptionally important consideration in many steel mill gear drives. They are available in the proper range of viscosities for every application, varying from 55 to 1050 S.U.V. @ 210°F. They are nonfoaming, tenacious, stable in storage or in use, and are noncorrosive.

For specific recommendations for your equipment, and for expert help on any problem that involves lubricants or lubrication, call in a Gulf Lubrication Engineer today. Write, wire, or phone your nearest Gulf office. Gulf Oil Corporation · Gulf Refining Company, Pittsburgh 30, Pa.

GULF INDUSTRIAL LUBRICATION

powerful helper for

rolling and pipe mills



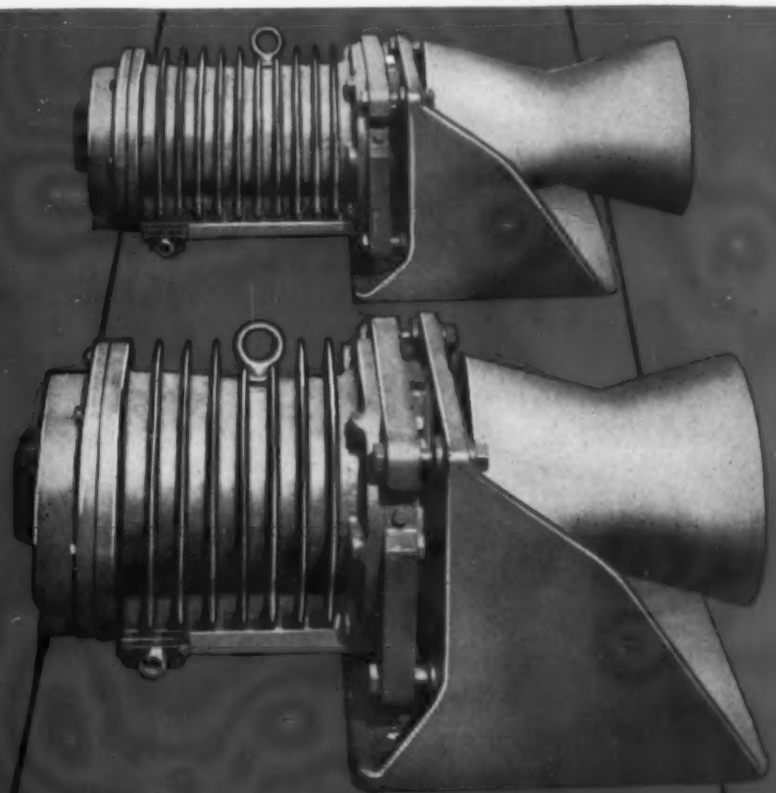
LOEWY

INDIVIDUALLY-DRIVEN MOTOR ROLLER UNITS

for heavy-duty service wherever Roller Tables are required

CHECK THESE EXCLUSIVE FEATURES!

- **AUTOMATIC SPEED CONTROL**
  Adjusts automatically to weight of load. Individual rollers directly motor driven; no couplings, reduction or bevel gears.
- **SPECIALLY DESIGNED LOEWY MOTOR**
  Extra sturdy, shockproof, heavy antifriction bearings. Need for flexible couplings eliminated.
- **LOW INERTIA ROTOR**
  Ideally suited to constant start-stop operation. Can be safely stalled under full load. Stator insulated to withstand up to 350° F.
- **REDUCED OPERATING COSTS**
  No special maintenance crews needed. One or two spare rollers sufficient for upkeep of entire installation. Units consume less current than any other roller conveyor.
- **TABLE FORMS PERMIT FLEXIBLE ARRANGEMENT**
  Straight or curved lines may be readily formed and can be easily broken into individually controlled groups. Free passage is possible between rollers, a feature especially valuable for finishing departments.



LOEWY ROLLING MILL DIVISION

HYDROPRESS INC.

ROLLING MILLS AND ROLLING MILL EQUIPMENT

366-568 Lexington Avenue General Electric Bldg., at 51st Street **New York 22**

CHICAGO • DETROIT • SAN FRANCISCO • SEATTLE • WASHINGTON, D. C.

Precision Built

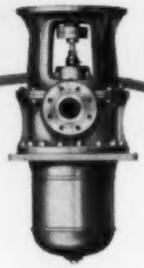
MATHEMATICAL FORMULAE...KNOWLEDGE BORN OF EXPERIENCE AND THE HUMAN EQUATION ARE COMBINED IN THE DESIGN DETAILS...TOP GRADE MATERIALS OF CONSTRUCTION AND PRECISION WORKMANSHIP ARE COMBINED IN THE FABRICATION

to make every

Pacific

A Boiler Feed Pump of Quality

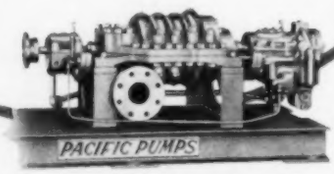
BUT THE POWER OF YOUR GOOD WILL PROVIDES THE CONCLUSIVE EVIDENCE OF THEIR ACCEPTANCE



PACIFIC TYPE WBF

PACIFIC TYPE ABF

PACIFIC TYPE IBF



PACIFIC TYPE JBF

For Central Station, Industrial and Marine Services

YESTERDAY...

The total capacity of all boiler feed pumps built and installed by Pacific during the year 1930 was 15,000 KW. In 1939 it was only 65,000 KW.

The first Pacific boiler feed pump for central station service was built in 1940...the first for marine service in 1944. The total capacity of all Pacific boiler feed pumps built in 1950 was 4.75 million KW.

TODAY...

the 9.5 million KW capacity in various stages of construction is conclusive evidence of your acceptance of

PACIFIC *Precision Built* BOILER FEED PUMPS

Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES — **HUNTINGTON PARK, CALIFORNIA**

BF-14

Export Office: Chanin Bldg., 122 E. 42nd St., New York Offices in All Principal Cities

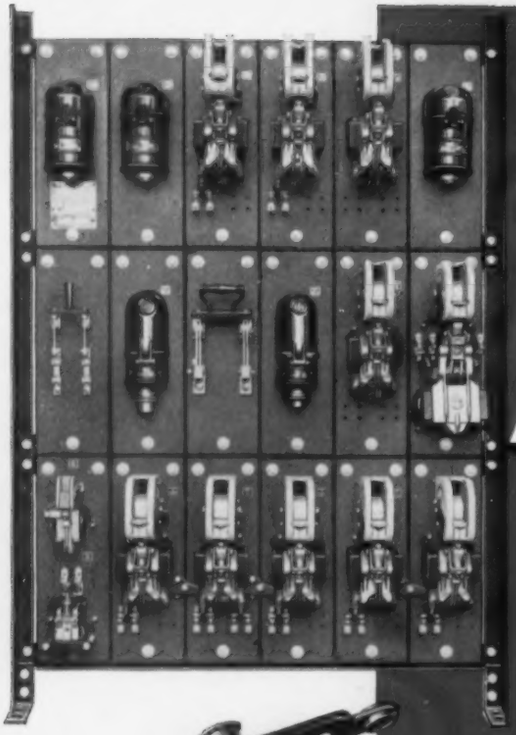
MESTA GEAR DEPARTMENTS

Mesta gear cutting equipment includes all the necessary heavy duty machine tools to produce gears up to the largest sizes used by industry. These ruggedly constructed machine tools, including Mesta Gear Planers and Hobbers, are specially designed to enable skilled workmen to produce the most accurate gear teeth possible. A Mesta 16 Foot Heavy Duty Gear Hobber is illustrated.

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA



LOOK for these NAMES when buying Motor Control

1 LINE-ARC Contactors
2 TIME-CURRENT Acceleration (D-c)
3 FREQUENCY RELAY Acceleration (A-c)
4 WRIGHT CIRCUIT Hoist Control (D-c)
5 YOUNGSTOWN Hoist Limit Stops
6 TYPE WB Brakes
7 CAM Master Switches
8 MANUAL-MAGNETIC Disconnect Switches
9 CONTRA-TORQUE Hoist Control (A-c)
10 TAB-WELD Resistors

These FUNCTIONAL NAMES Speak for Themselves

TIME-CURRENT CONTROL for D-c Motors

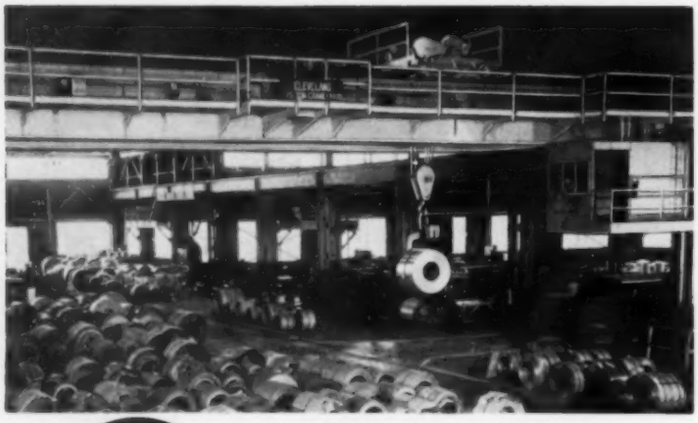
Aids OUTPUT

Motors accelerate *fast* from a standing start — *quicker* from a coasting start with NO change in relay adjustment.

Only one moving part in the TIME-CURRENT acceleration relays — magnetically centered in its short movement.

Top view of relay (with hinged cover removed) showing relay contacts in normal position.

Watch a TIME-CURRENT Controlled crane operate, or better still take a ride on one, and note the outstanding performance of this self-timing system of control. From a standing start, the crane gets under way easily with normal time per step for smooth acceleration. Put the master switch in "neutral" and coast. Then re-apply power for travel in the same direction—reduced time for each step results in *quicker* acceleration than from a standing start. This is an *exclusive* characteristic of EC&M TIME-CURRENT Control and operators use it to advantage in taking the swing out of a load, in making quick moves where fast response is valuable to increased output. For new cranes, or when revamping existing installations, specify EC&M Control.



15-Ton Mill Crane responds quickly under EC&M Control.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Continental

HIGH LIFT SLABBING MILL

Complete Rolling Mill Installations:

BLOOMING MILLS • STRUCTURAL MILLS • RAIL MILLS
BILLET MILLS • ROD MILLS
BAR MILLS • MERCHANT MILLS • SLABBING MILLS
UNIVERSAL MILLS • PLATE MILLS
HOT STRIP MILLS • COLD STRIP MILLS • TEMPER MILLS
ROLL LATHES • SPECIAL MACHINERY

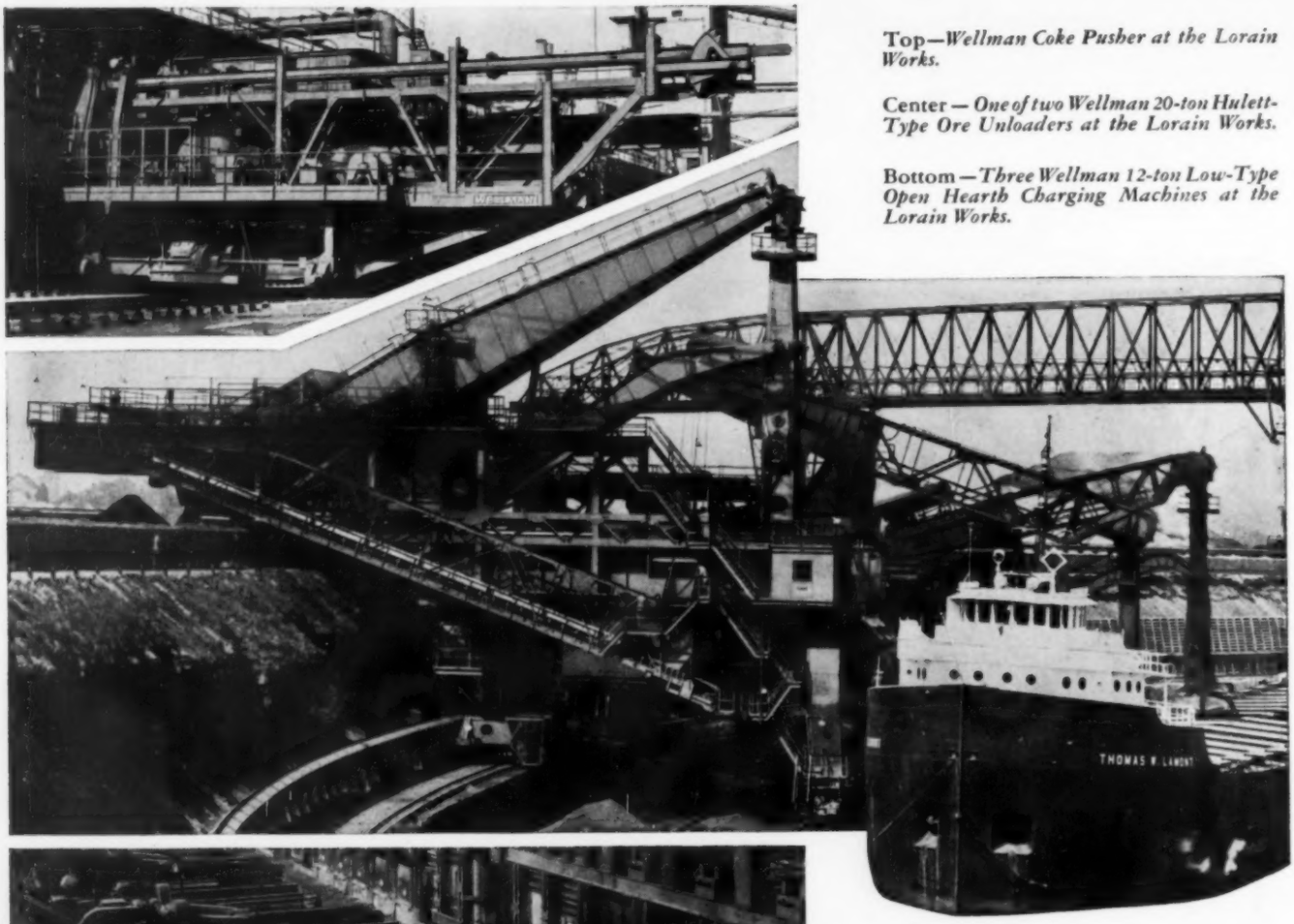
CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

CHICAGO • PITTSBURGH

Plants at: *East Chicago, Ind.* • *Wheeling, W. Va.* • *Pittsburgh, Pa.*

CONTINENTAL
Foundry & Machine
Company



Top—*Wellman Coke Pusher at the Lorain Works.*

Center—*One of two Wellman 20-ton Hulett-Type Ore Unloaders at the Lorain Works.*

Bottom—*Three Wellman 12-ton Low-Type Open Hearth Charging Machines at the Lorain Works.*

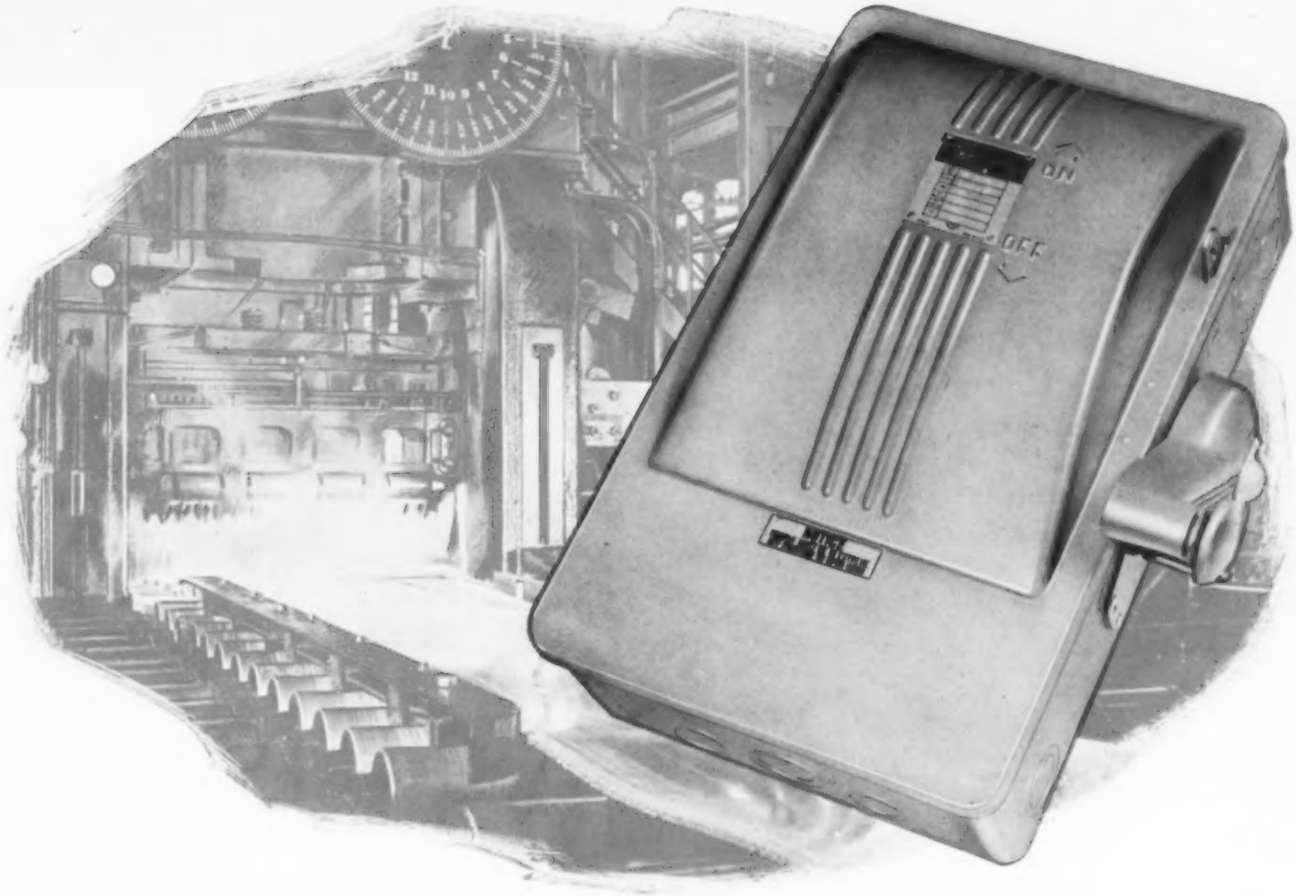
How Wellman serves the Lorain Works

● These pictures show three important applications of Wellman equipment at the Lorain Works of National Tube Company. These installations are typical of the contributions which Wellman has made to the steel industry for more than 50 years.

Wellman is recognized the world over as a pioneer and leader in the engineering, manufacturing and installation of heavy duty machinery for the steel industry. We welcome your problems.

THE WELLMAN ENGINEERING COMPANY

7031 CENTRAL AVENUE • CLEVELAND 4, OHIO



Less Outage...More Tonnage

with New *Life-Line* Safety Switch

Three shift circuit protection? Certainly—but only equipment with the stamina demanded by hard and frequent usage can give such protection.

The new Westinghouse Life-Line Safety Switch offers you more than ever before obtainable. In addition to basic simplicity of design, long-life giving features are diamond-pointed break jaws and extended blades to hold burning and beading outside contact area, and "De-ion®" Quenchers to knock out hot arcs. One-piece copper construction has fewer joints per pole, eliminating excessive internal heating.

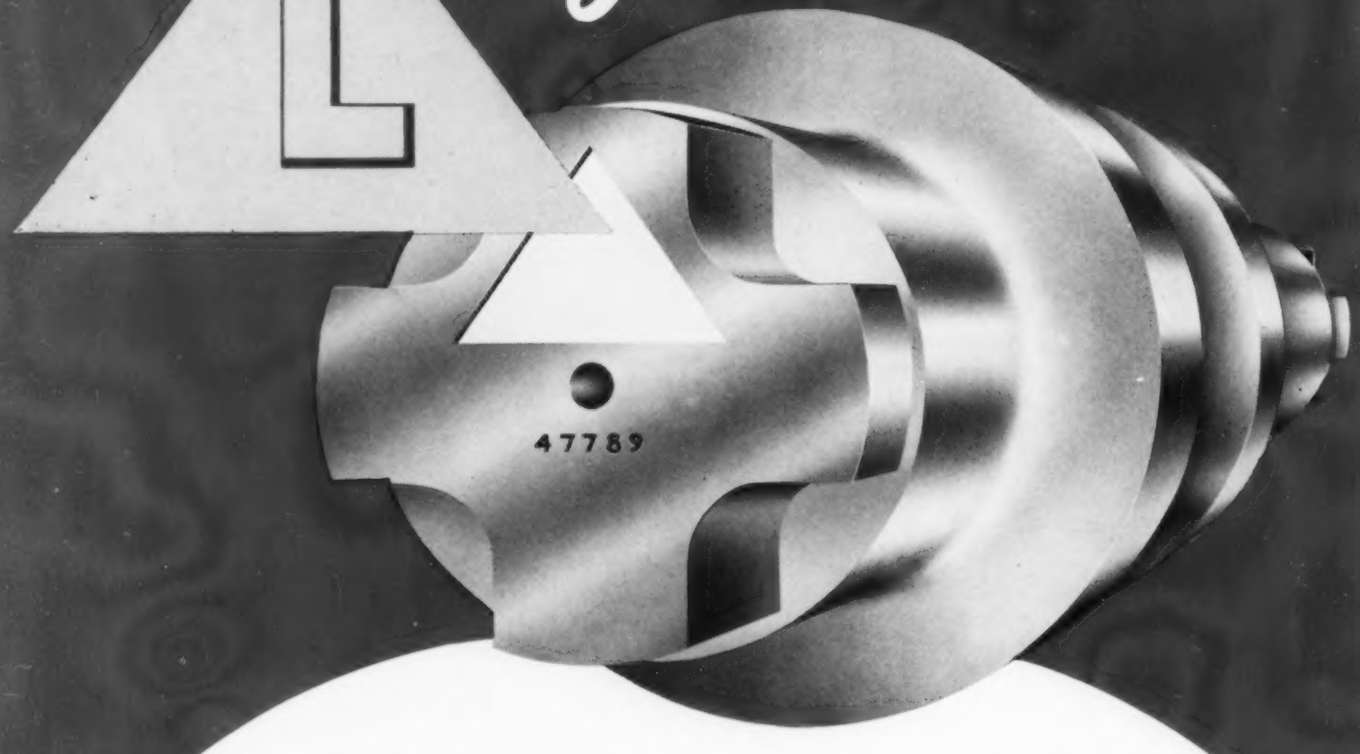
Yes, protection—and with minimum attention. The proof? Front removable copper parts and base assembly, requiring only a screw driver, simplify maintenance and replacement. The base is of one-piece insulating composition, moisture-proof and resistant to carbonization and breakage. Wrap-around welded enclosure minimizes cabinet distortion. Self-aligning fuse-clip reinforcements assure constant contact pressure at all times.

For further facts, contact your Westinghouse Distributor, or write for Booklet B-4723, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-30086

YOU CAN BE SURE... IF IT'S
Westinghouse
Life-Line
SAFETY SWITCHES

This marks the most efficient rolls

L . . . for your mill



LEWIS ROLLS

LEWIS PLAIN CHILLED IRON ROLLS · LEWIS MOLYBDENUM CHILLED IRON ROLLS LEWIS "X" and LEWIS "XA" ROLLS · LEWIS SUPERIOR "X" ROLLS · LEWIS ATLAS and ATLAS "B" ROLLS · LEWIS SPECIAL PROCESS ROLLS · LEWIS AJAX DUPLEX ROLLS · LEWIS CLIMAX and AJAX ROLLS · LEWIS SPECIAL TUBE MILL ROLL

may we have the opportunity of studying your requirements and submitting our recommendations

MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Lee Wilson

ANNEALING FURNACE DATA SHEET

NUMBER TWO

BASIC ADVANTAGES OF LEE WILSON SINGLE-STACK PORTABLE BASE FURNACES:

1. BETTER QUALITY
2. HIGHER PRODUCTION
3. LOWER FUEL COSTS
4. LOWER FIRST COST
5. LOWER MAINTENANCE
6. LOW HANDLING COSTS

SINGLE-STACK PORTABLE BASE FURNACE INCREASES PRODUCTION

ACCELERATED HEATING AND COOLING

Users of the Single-Stack Portable Base type annealing furnace realize more tons per stand per hour than those employing any other method. Accelerated heating and cooling are important factors. The heating tubes are equidistant from every part of the coil. (See Fig. 3.) In a multiple-stack furnace the surfaces of the coils are necessarily at varying distances from the heating source. This means the furnace does its job faster – more efficiently.

MAXIMUM LOADING FACTOR

It is difficult to accumulate coils of uniform size and stack them evenly in a multiple-stack furnace – the more stacks the more difficult. (Fig. 1) To prevent overheating the smallest stacks, the heat input must be reduced in the whole furnace.

UNIFORM LOADING

Smaller coils then "loaf" while waiting for larger coils to heat. Reduced input requires longer time to bring up to heat. Obviously the cooling down operation, too, requires a longer operation. Single-Stack Portable Base furnaces can be loaded uniformly and the heating is without delay. (Fig. 2) Heating and cooling time is directly proportional to size of coils. No waiting, overheating or reanneal. Minimum number of stands are out of operation. Result: Single-Stack Portable Base production is for all practical purposes double that of larger multiple stacks.

For complete information send for fully illustrated 20-page booklet.

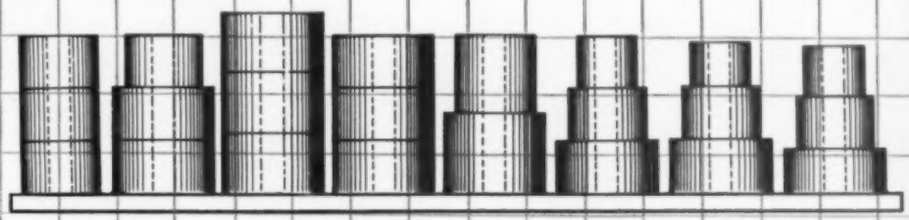


Fig. 1 – Typical piling in an eight-stack furnace, spread in a single line to show the unevenness of coil stacks. The furnace must be held to make sure the largest stack is thoroughly annealed. This charge would require approximately 44 hours.

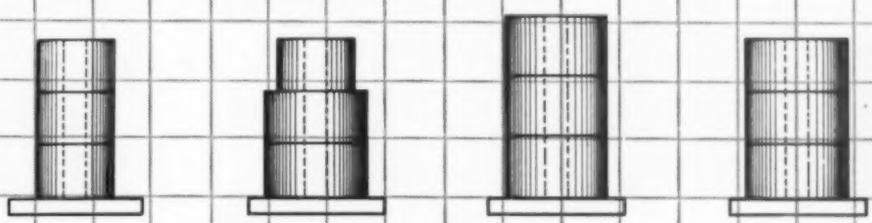
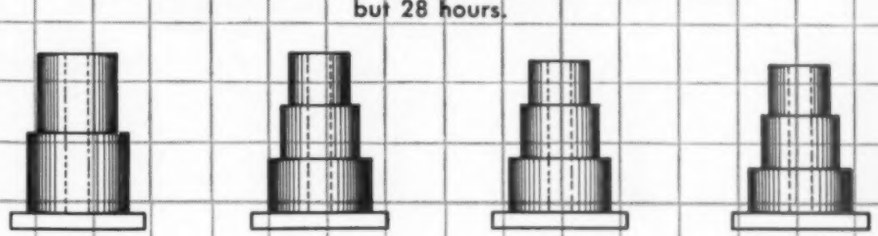


Fig. 2 – The same piling for Single-Stack Portable Base furnaces. The smaller stack would be complete in 17 hours. Because there is no fear of overheating small stacks, even the largest stack would be ready to go in but 28 hours.



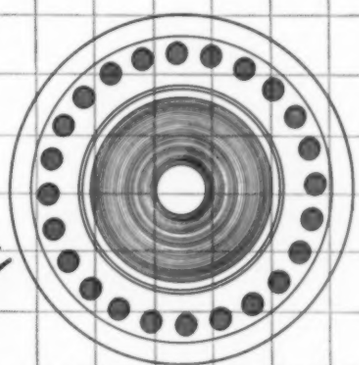
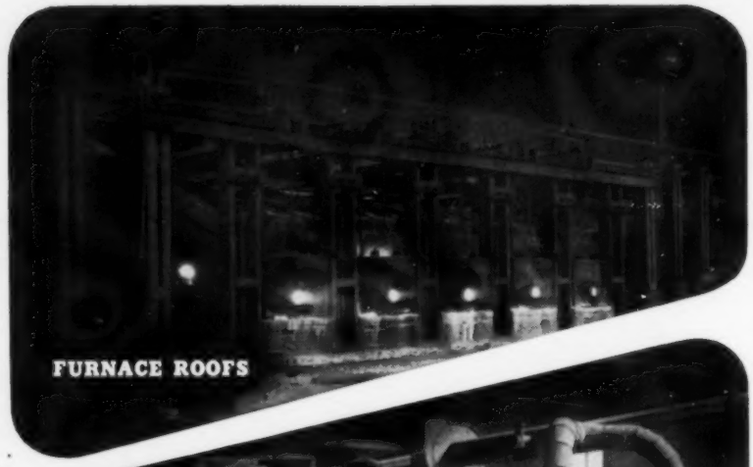
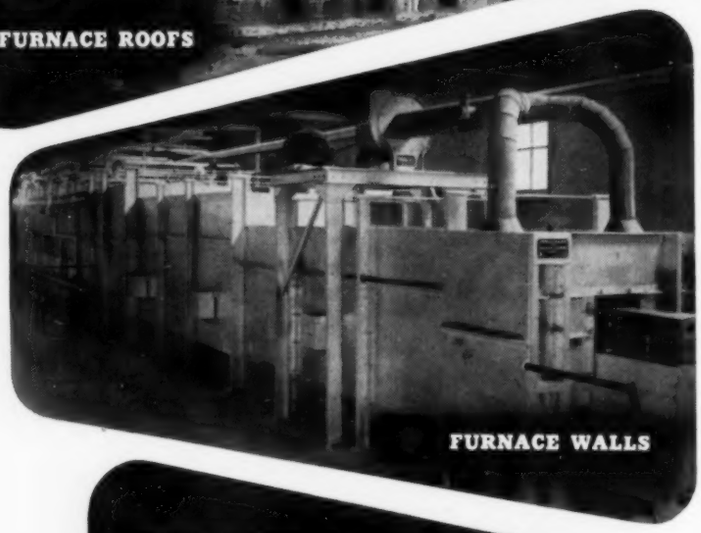


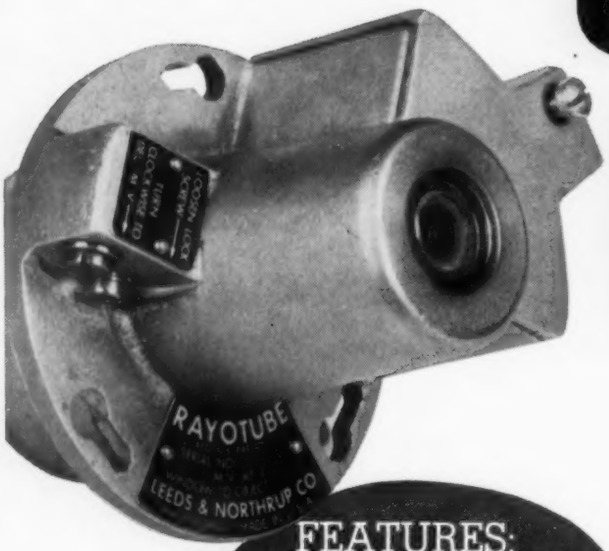
Fig. 3 – Single-Stack Portable Base furnaces bring the charge to the correct heat faster because the heating tubes are equidistant from every part of the coil. What's more the heating can be regulated to make sure just the right amount of heat is applied at the right times.

Lee Wilson
ENGINEERING COMPANY, INC.
CLEVELAND, OHIO

This RAYOTUBE suits all locations COOL OR HOT







FEATURES:
Quick installation
" sighting
" response to temperature

Here is the radiation-sensing unit for 9 out of every ten radiation-pyrometer uses. It adds the storekeeping advantages of smaller instrument inventory to the operating advantages* of all Rayotubes. Many hundreds of this type are now in use. Among its features:

1. Easy to install because it needs no water-jacket unless the head housing itself (shown above) reaches interior temperature of 350 F. Even then, no harm is done below 450; accuracy decreases above 350, but returns fully as temperature drops. In practical operation, even 350 is reached on very, very few installations.

When replacing a present jacketed Rayotube with this type, it is not necessary to tear out the jacket and piping. Simply insert Rayotube in jacket and turn off water if no longer needed.

2. New, quick-sighting optical system shows exact area from which temperature is being recorded. This is especially helpful when instrument is being positioned to point down an open-end tube and measure directly the surface temperature of parts being heated.

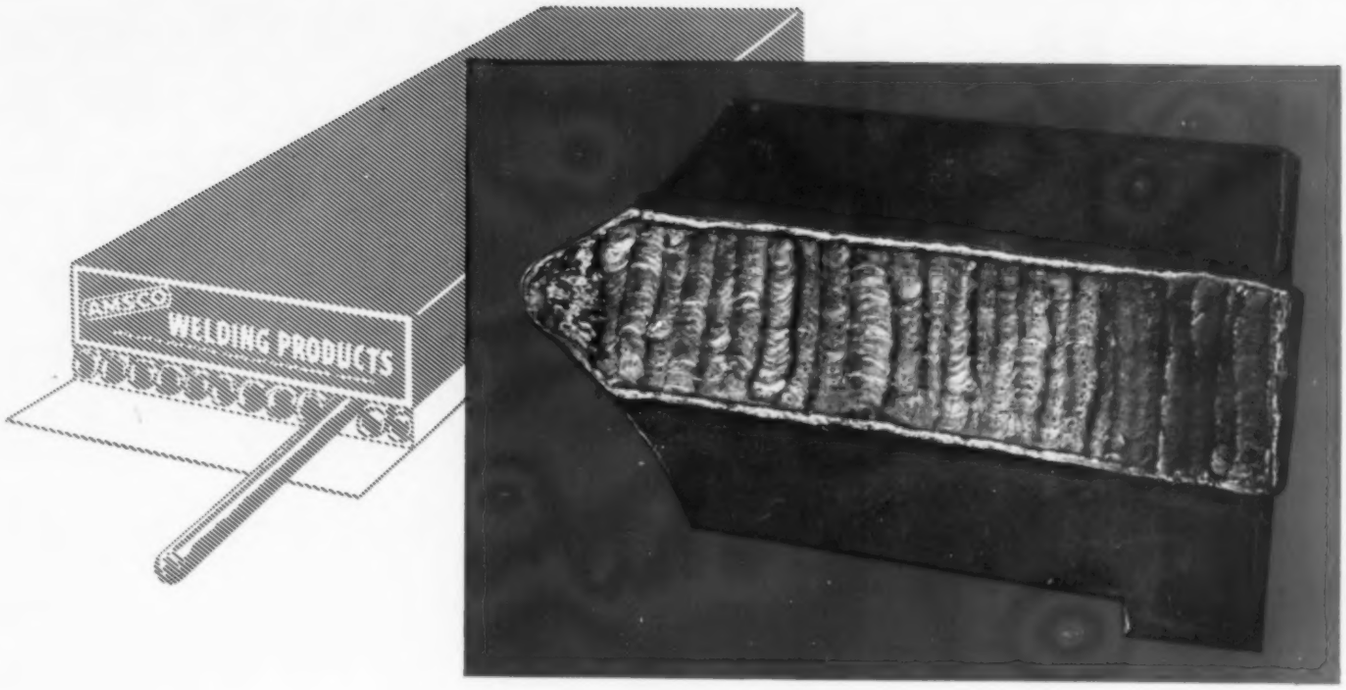
3. Can be used with Speedomax electronic instruments as well as with Micromax equipment—which blanket every temperature-recording and/or controlling job in industry.

This Rayotube is No. 8890. Any L&N office, or headquarters at 4942 Stenton Ave., Phila. 44, Pa., will send details on request.

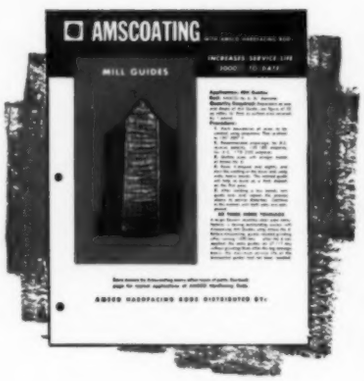
*Any L&N man can give details

LEEDS & NORTHRUP
MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jrl. Ad NS3(3)



How to run more tonnage — with fewer shutdowns



How to Amscoat Mill Guides . . .

This procedure sheet gives complete details . . . the AMSCO electrode to use and method of application. Also lists electrode recommendations for other iron and steel applications. Free copy on request.

An example of how AMSCOATING with Amsco Hardfacing Electrodes can save materials, manpower and money.

A large Eastern seamless steel pipe manufacturer can quote—from the record—on the big savings possible through Amscoating!

Before Amscoating, Mill Guides had to be removed and reground after running an average of 1200 tons. After Amscoating with an Amsco electrode specially developed to stand up under heat and abrasion, the same guides ran 37,117 tons without grinding—*over 30 times longer*—and were still in good condition for further service!

Amscoating can reduce shutdowns, repairs and replacements, as demonstrated by this actual case history. The inevitable result is that production goes *up* . . . and maintenance costs *down.* Write today for catalog on dollar-saving Amsco Electrodes and name of your nearest Amsco Distributor.

AMSCOATING
THE RIGHT WAY TO SAY HARDFACING

American Brake Shoe Company

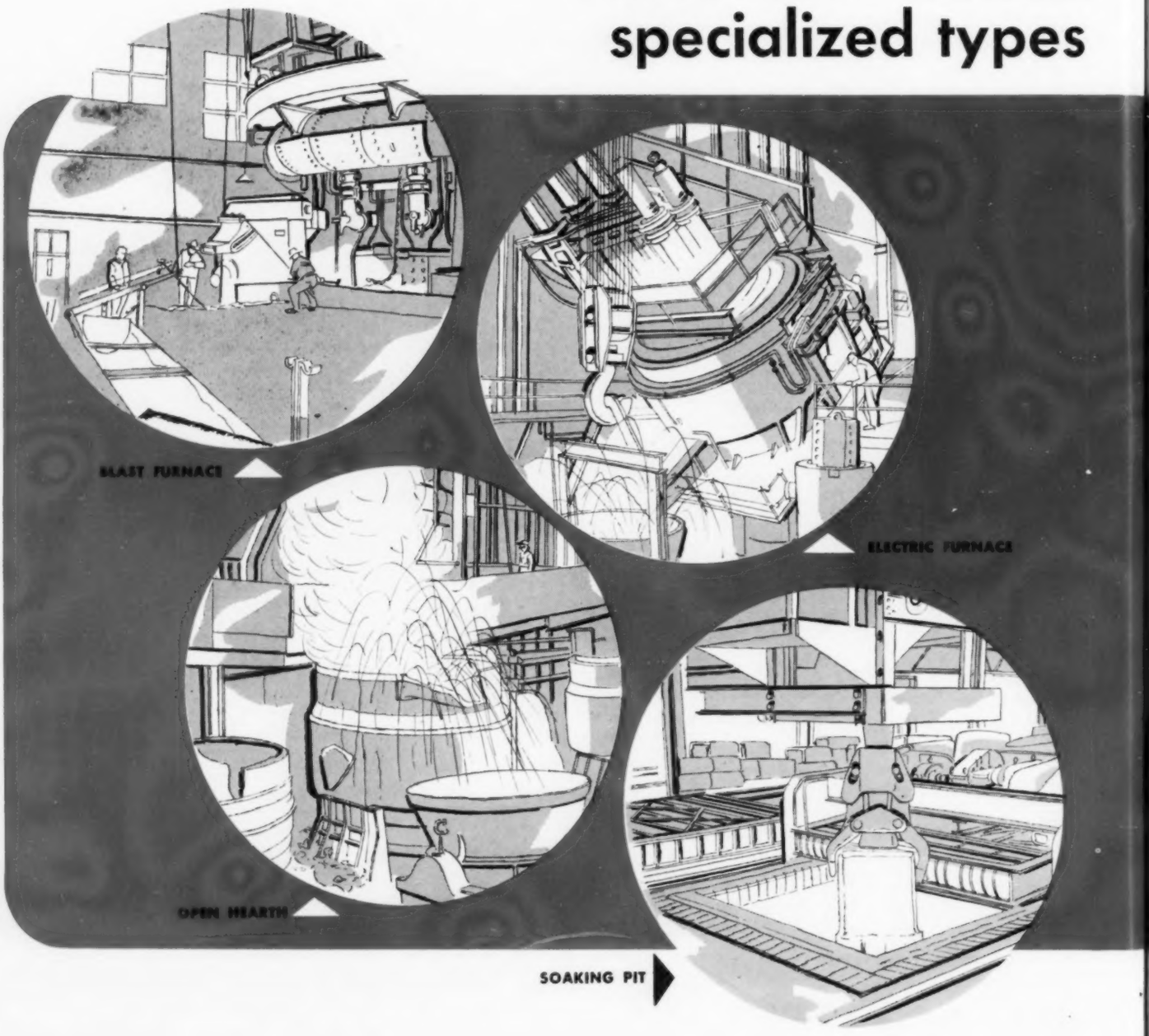
AMERICAN MANGANESE STEEL DIVISION
411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

Harbison-Steel Mill

THE WORLD'S *Most Complete* REFRACTORIES SERVICE

specialized types



Walker Refractories
for every requirement

Every heat of steel you pour, every ton you cast or roll, consumes a certain amount of refractories. The exact amount—which inevitably has a direct bearing on your cost of production—is determined by your selection of the refractories best suited to meet the specific requirement for each combination of operating conditions where heat is employed.

Harbison-Walker offers the most complete range of steel mill refractories comprising all classes of basic, high-alumina, silica, fireclay and insulating refractories, as well as plastic fire brick, castables, mortars and cements. Our Technical Service Department will be glad to assist you in selecting the types and brands of Harbison-Walker products that will give longest life in each application.

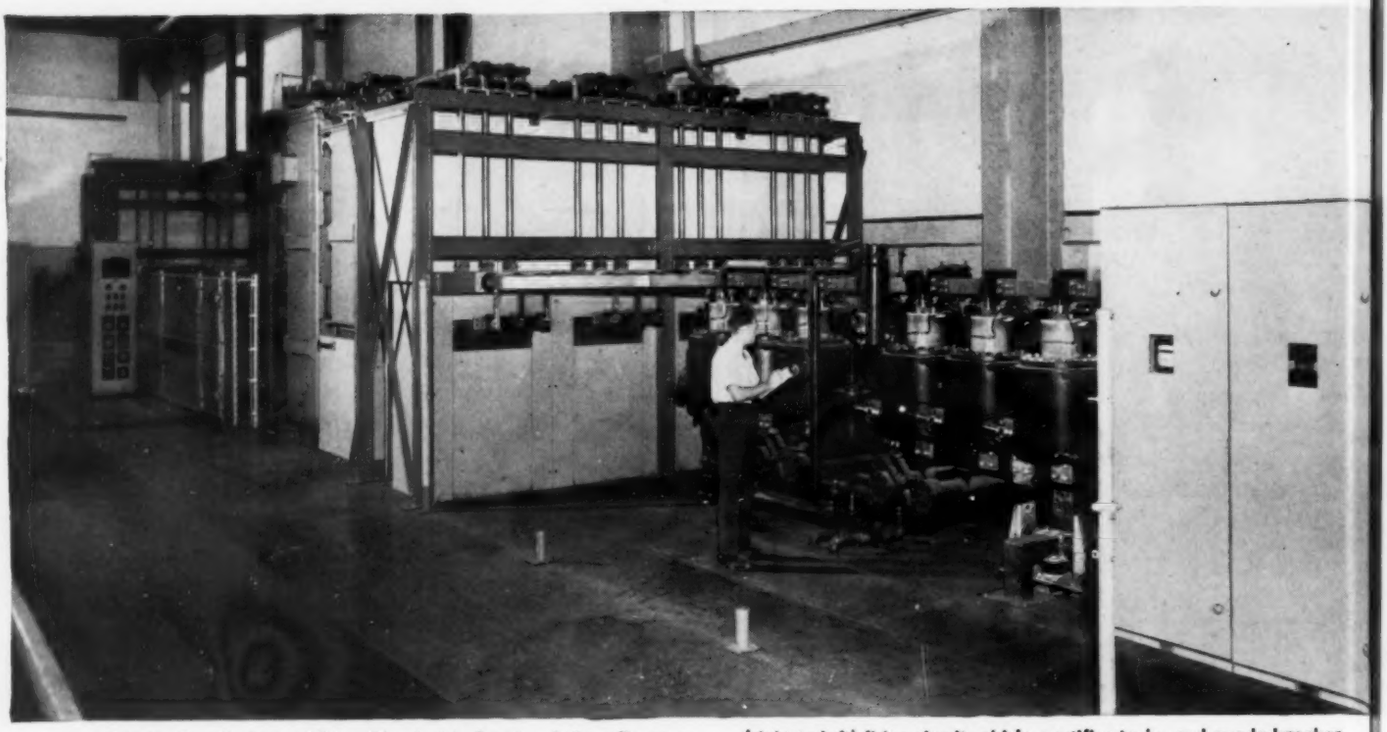
HEAT TREATING

COKE OVEN

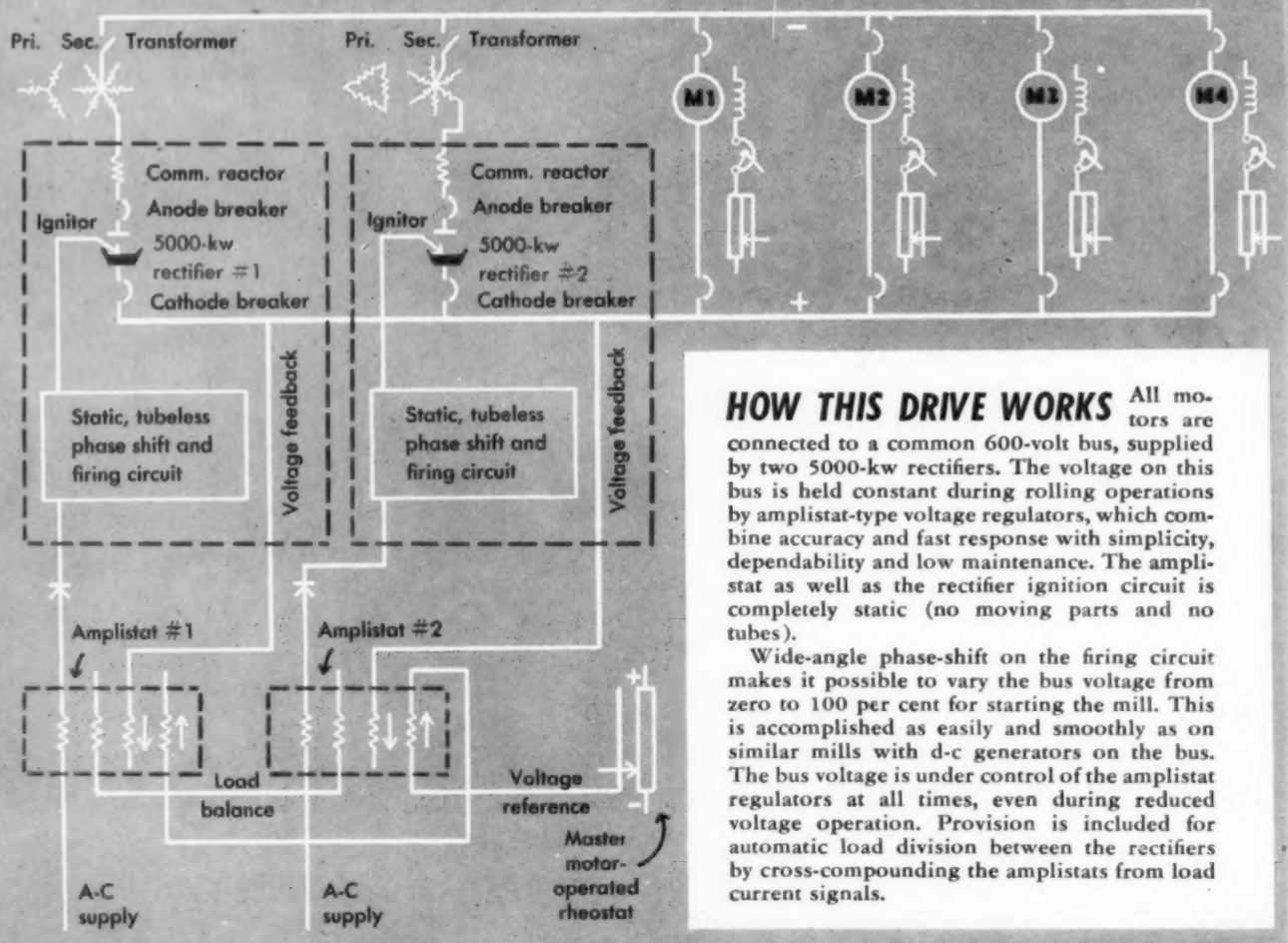
HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES

World's Largest Producer of Refractories

General Offices: Pittsburgh 22, Pa.



Outstanding feature of this mill's electrical system is its reliance on rectifiers alone for its main drive's d-c power supply. Photo shows (right to left) firing circuit cubicle, rectifier tanks, and anode breaker of one of the two G-E 5000-kw rectifiers.

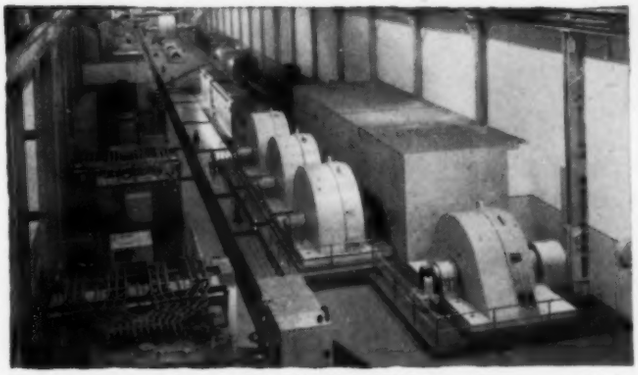


HOW THIS DRIVE WORKS

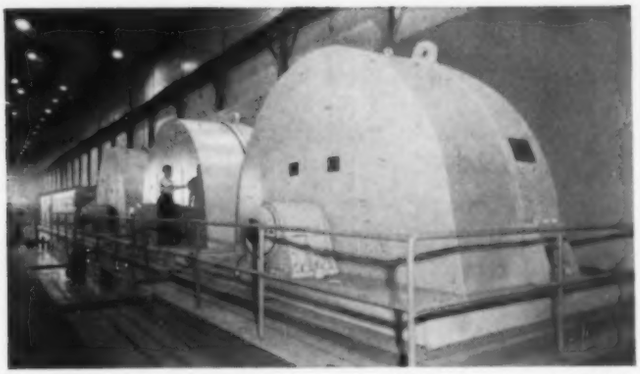
All motors are connected to a common 600-volt bus, supplied by two 5000-kw rectifiers. The voltage on this bus is held constant during rolling operations by amplistat-type voltage regulators, which combine accuracy and fast response with simplicity, dependability and low maintenance. The amplistat as well as the rectifier ignition circuit is completely static (no moving parts and no tubes).

Wide-angle phase-shift on the firing circuit makes it possible to vary the bus voltage from zero to 100 per cent for starting the mill. This is accomplished as easily and smoothly as on similar mills with d-c generators on the bus. The bus voltage is under control of the amplistat regulators at all times, even during reduced voltage operation. Provision is included for automatic load division between the rectifiers by cross-compounding the amplistats from load current signals.

Another example of G-E drive engineering at work!



Motor room, seen from overhead crane cab, shows how compactly the two G-E rectifiers (left) fit in this motor room of limited width.



Main drive motors for mill's four stands include these three G-E 5000-hp d-c motors, plus another 3500-hp direct-connected unit, not shown.

Rated at 1550 fpm, this 86-inch hot strip mill produces heavy-gage sheet steel for welded pipe and other uses. Strip passes from right to left.

Operating pulpit includes (left to right) flying shear desk, screw-down desk, and speed desk. Mill is directly opposite the operators.

G-E rectifiers power main drives on large hot strip mill

Part of co-ordinated G-E equipment, they supply d-c power to drive new 86-in. finishing mill at nearly 1500 fpm

Here's another G-E first! This new 86-inch hot strip finishing mill in a large Western steel mill—electrically equipped and engineered throughout by General Electric—depends on two 5000-kw G-E rectifiers alone to convert a-c to the d-c power required for its main drives. This unique, complete drive installation includes main and auxiliary motors, control equipment, switchgear, transformers and ventilating equipment. G-E rectifiers offer advantages like these:

Low installed cost.

Fast, economical installation. Rectifiers, being static, do not need heavy foundations.

Little floor space needed. Rectifiers can be easily located on a balcony, or split up into sections, or placed nearer the centers of d-c load to cut the length and expense of d-c feeders.

Substantial power-cost savings. Rectifier efficiency is high, especially at light loads.

Low maintenance costs—minimum of moving parts, periodic inspections reduced to minimum.

Excellent service continuity. Rectifier tanks are easily, quickly replaced when necessary.

Low ventilating costs. Major losses of rectifiers are removed by water cooling.

Whatever solution is right for *your* drive engineering problem, you'll find it faster, easier, and at less cost by letting a G-E steel-mill specialist team up with your technical staff. Call him in—early in your planning. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

659-82

GOULD

Plus-Performance Plan

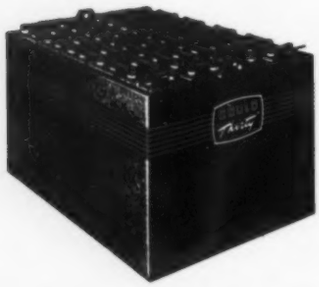
Industrial truck batteries should be cleaned whenever any noticeable quantity of dirt has accumulated.

GIVES YOU THIS TIMELY TIP—

CLEAN BATTERIES LAST LONGER!

Because battery cleanliness prevents external current leakage and grounds, regularly scheduled cleaning is essential for maximum battery service. Information on proper battery maintenance is available to you through the GOULD PLUS-PERFORMANCE PLAN—a complete system of manuals, articles, specifications, bulletins, charts and graphs dealing with this and practically every other battery problem.

GOULD PLUS-PERFORMANCE PLAN material tells you and shows you how to select, charge and handle, maintain and determine the condition of your batteries . . . and it's FREE, without obligation! Use it and you can extend battery service as much as 50%! Send today for booklet explaining the plan.



The Gould "Thirty" with "Z" Plates—America's Finest Industrial Truck Battery

HERE'S HOW TO CLEAN YOUR BATTERIES

Batteries should be kept clean and dry. When cleaning be sure all vent plugs are in place and tight. Wash batteries with water, then blow off excess and dry with compressed air. Neutralize acid on covers and other parts of the battery with ammonia or baking soda at least once a month. Terminals and connectors should be cleaned with baking soda and water.

During cleaning, observe condition of steel tray and, if corrosion is evident, wash and paint tray with asphaltic, acidproof paint or melted battery-sealing compound.

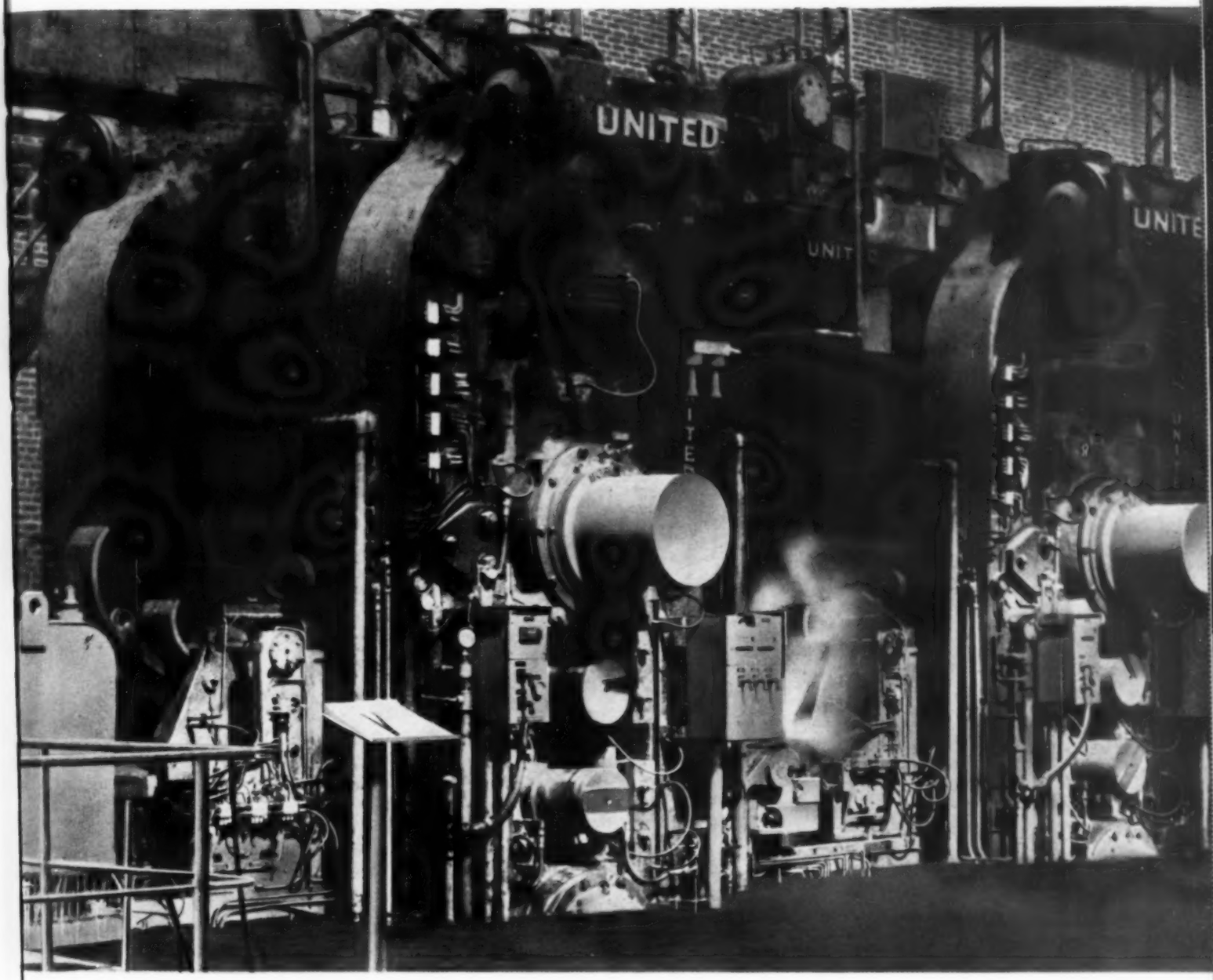
GOULD STORAGE BATTERIES

GOULD-NATIONAL BATTERIES, INC., TRENTON 7, NEW JERSEY

Always Use Gould-National Automobile and Truck Batteries

UNITED

4-HIGH 6-STAND CONTINUOUS HOT MILL



UNITED

ENGINEERING AND FOUNDRY

COMPANY

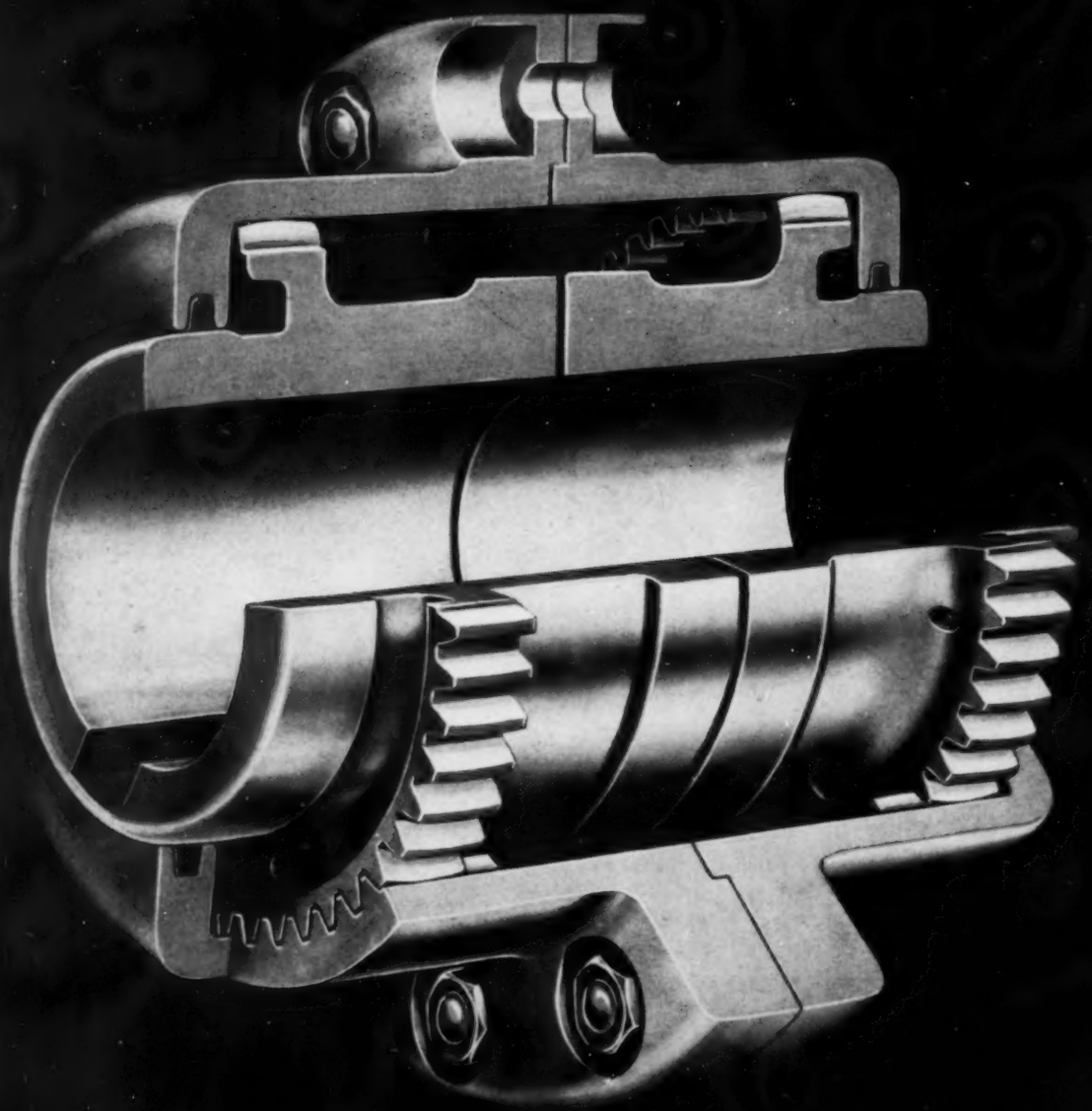
PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH • VANDERGRIFT • NEW CASTLE
YOUNGSTOWN • CANTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

STEEL MAKERS ABROAD

ALSO BUY

MORGAN
WORCESTER
ROLLING MILLS

MORGAN MILLS ABROAD

UNITED STEEL COMPANIES, LTD., England
1—21 Billet Mill
1—18 Billet Mill
1—12 Merchant Mill
1—10 Wire Rod Mill
1—12 Strip Mill
5 Mills

WHITEHEAD IRON & STEEL CO., England
1—10 Bar, Hoop, Tie and Rod Mill
1—12 Strip Mill
1—10 Rod and Merchant Mill
1—12 Merchant Mill
4 Mills

SOC. ANON D'OUGREE-MARIHAYE, Belgium
1—10 Merchant and Strip Mill
1—10 Wire Rod Mill
1—19 Sheet Bar and Skelp Mill
3 Mills

BROKEN HILL PROPRIETARY CO., Australia
1—18 Billet and Sheet Bar Mill
1—10 Wire Rod Mill
1—12 Merchant, Skelp and Strip Mill
3 Mills

DOMINION IRON & STEEL CO., Canada
1—16 Billet Mill
1—10 Rod and Merchant Mill
1—10 Rod and Merchant Mill
3 Mills

TATA IRON & STEEL CO., India
1—24 Billet Mill
1—18 Billet and Sheet Bar Mill
1—12 Billet and 8" Merchant Mill
3 Mills

ACIERIES DE LONGWY, France
1—21 Billet Mill
1—18 Billet and Sheet Bar Mill
1—10 Wire Rod Mill
3 Mills

STEWARTS & LLOYDS LTD., England
1—12 Skelp Mill
1—19 Skelp Mill
1—10 Skelp Mill
3 Mills

GUEST, KEEN, NETTLEFOLDS, LTD Wales
8—10 Rod Mills
1—10 Merchant and Strip Mill
3 Mills

STEEL COMPANY OF CANADA, Canada
1—18 Billet and Sheet Bar Mill
1—10 Wire Rod and Merchant Mill
2 Mills

DENAIN & ANZIN, France
1—21 Billet Mill
1—18 Billet and Sheet Bar Mill
2 Mills

FRIEDRICH KRUPP, A. G., Germany
1—28 Billet and Slab Mill
1—19 Billet and Sheet Bar Mill
2 Mills

HOMECOURT, FORGES AND ACIERIES, France
1—21 Billet Mill
1—18 Billet and Sheet Bar Mill
2 Mills

AUSTRALIAN IRON & STEEL, LTD., Australia
1—19 Billet and Sheet Bar Mill
1—10 Merchant, Rod and Strip Mill
2 Mills

GUEST, KEEN & CO., England
1—12 Roughing Mill

J. MOUTON, France
1—10 Wire Rod Mill

ACIERIES DE FIRMINY, France
1—12 and 8 Merchant Mill

ALPINE MONTAN GESELLSCHAFT, Austria
1—10 Wire Rod Mill

GEORGS-MARIEN, BERGWERKS & HUETE-VEREIN, Germany
1—11 and 8 Merchant Mill

GEWERKSCHAFT DEUTSCHER KAISER, Germany
1—10 Hoop Mill

VEREWIGTE KOENIGS & LAURAHUETTE, Germany
1—8 Bar, Hoop, Tie and Rod Mill

RHEINISCHE STAHLWERKE, Germany
1—11 and 8 Merchant Mill

LLANELLY STEEL CO., Wales
1—18 Sheet Bar Mill

LANCASHIRE STEEL CORP., England
1—10 Merchant and Strip Mill

BRITISH (G.K.B.) IRON & STEEL CO., Wales
1—19 Billet and Sheet Bar Mill

SOCIETE ANONYME DE LA CHIERS
1—10 Strip and Rod Mill

AMTORG TRADING CORP., Russia
1—10 Wire Rod Mill

NEW JARROW STEEL CO., England
1—10 Merchant and Strip Mill

NEDERLANDSCHE KABELFABRIEK, Holland
1—10 Rod Finishing Mill

JOHN LYSAGHT, LTD., England
1—19 Billet Mill

ACINDAR INDUSTRIA ARGENTINA DE ACEROS S. A., Argentina
1—10 Merchant, Rod and Skelp Mill

SOC. MINIERE ET METALLURGIQUE DE RODANGE, Luxembourg
1—10 Rod Finishing Mill

DOMNARFVETS, JERNVERK, Sweden
1—12 Merchant, Rod and Strip Mill

LANCASHIRE STEEL CORP., England
1—10 Merchant and Rod Mill

OESTERREICHISCHE ALPINE MONTANGESELLSCHAFT, Austria
1—24 —19 Billet and Sheet Bar Mill

ILVA ALTI FORNI e ACCIAIERIE d'ITALIA, Italy
1—10 Rod and Merchant Mill

BROKEN HILL PROPRIETARY CO. LTD., Australia
1—19 Strip and Skelp Mill

CONSETT IRON CO. LTD., ENGLAND
1—28 —21 Billet and Slab Mill

ALGOMA STEEL CORP., LTD., Canada
Merchant and Strip Mill

STEEL CORP. OF BENGAL, LTD., India
1—21 —19 Billet and Sheet Bar Mill

MORGAN
WORCESTER

ROLLING MILLS - MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

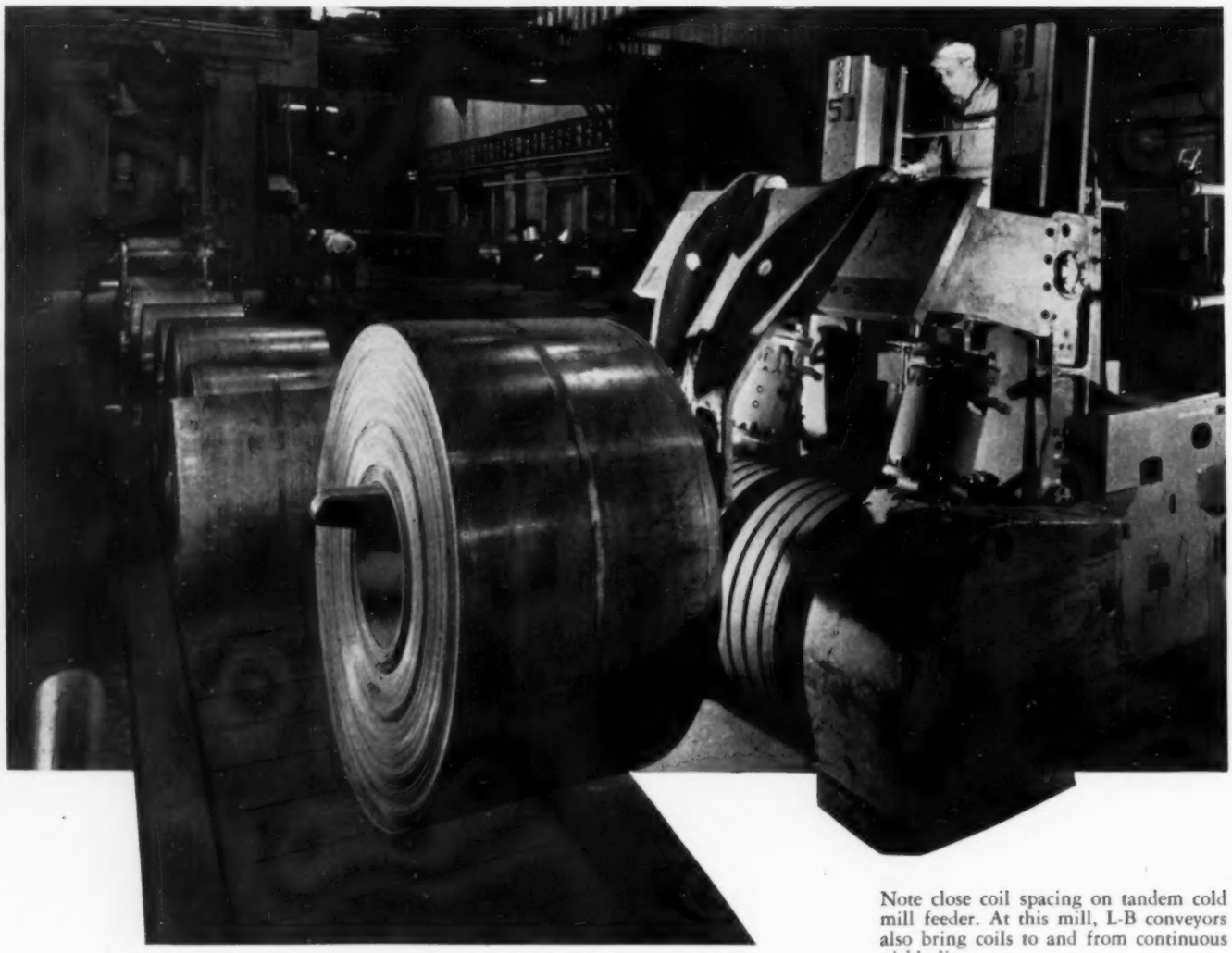
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative: International Construction Company
56 Kingsway, London, W.C. 2, England

RM-43

YIELD GOES UP...WASTE GOES DOWN

...with LINK-BELT coil handling conveyors



Note close coil spacing on tandem cold mill feeder. At this mill, L-B conveyors also bring coils to and from continuous pickle line.

Pallet feeders keep huge cold reduction mills rolling at high speed

There's no waiting for cranes or trucks when rolling mills are served by Link-Belt feeder-conveyors. That means the rated capacity of a mill can be fully realized.

Equally important, the gentle handling assures less scrap loss. Even on coils weighing as much as 75,000 pounds, there's no telescoping . . . no peening of edges.

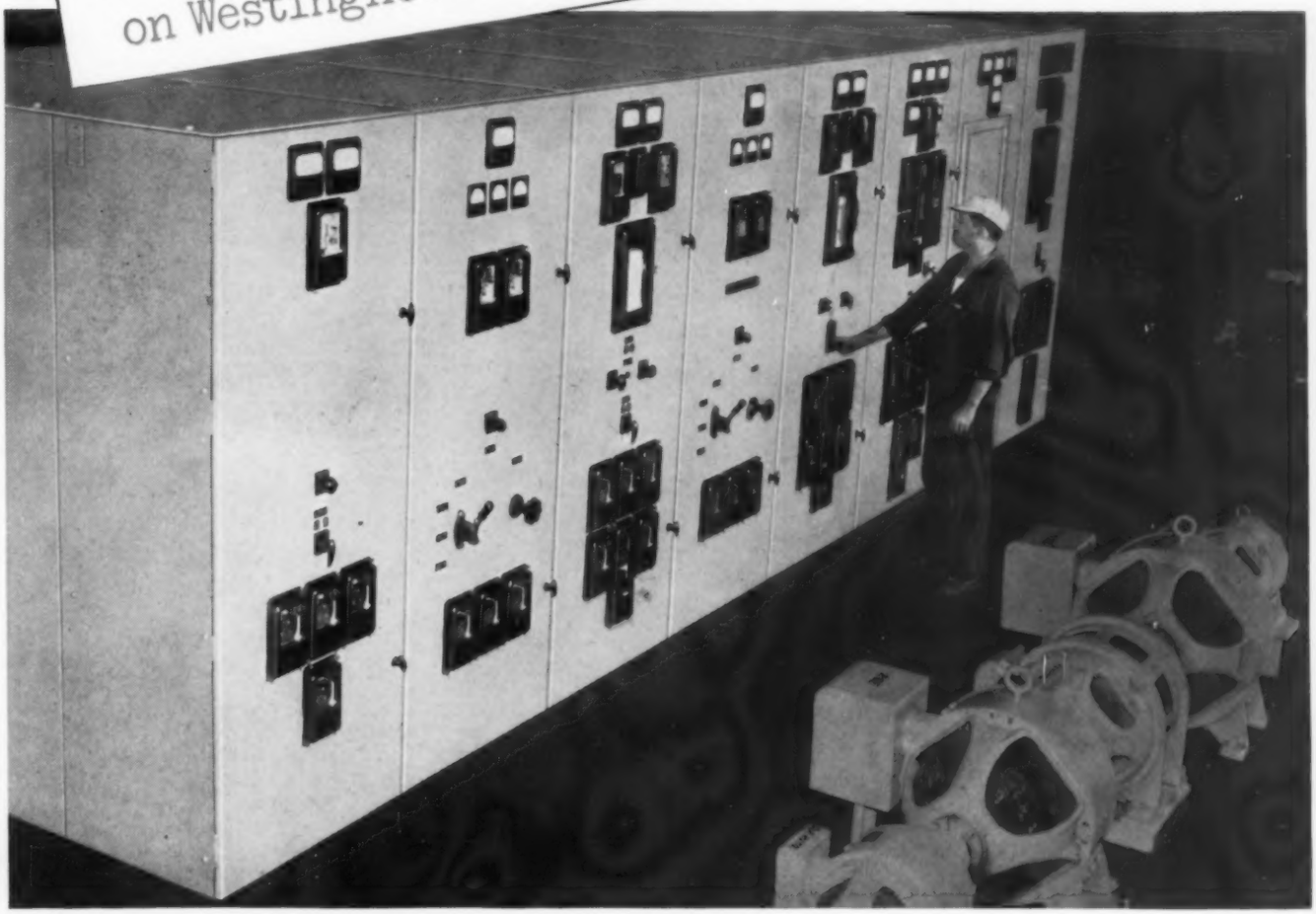
Link-Belt builds three different basic designs of coil handling conveyors to meet widely varying physical and economic requirements. Our engineers will work with your own engineers, consultants and builders of mill and process equipment — help you select the right system for your exact needs.

LINK-BELT

MATERIALS HANDLING, PROCESSING and POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Cleveland 15, Pittsburgh 13, Toronto 8, Springs (South Africa). Offices in principal cities. 12,567

Weirton Steel Company reports on Westinghouse Switchgear



"It's Safe...Dependable...Economical!"

This attractive installation of Westinghouse Metal-Clad Switchgear serves the No. 5 Tandem Mill at Weirton Steel Company, Weirton, W. Va. It also serves this user's interests in other respects as this statement indicates:

"Your complete factory-assembly of this unit enables us to reduce substantially normal ordering and installation costs. Less engineering time was required and the installation was made quickly and simply.

"From a safety standpoint, we particularly like its interlocking and isolation feature which eliminates hazards in operation. The unit has been entirely reliable in service."

Unusually low maintenance is another feature that's sure to increase this customer's satisfaction with Westinghouse Switchgear. Several important reasons—easy accessibility . . . drawout air breakers . . . exclusive "De-ion®" circuit interruption.

For complete information on Westinghouse Metal-Clad Switchgear, ask for Booklet B-4016. Contact your Westinghouse Representative or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60773

YOU CAN BE SURE... IF IT'S Westinghouse

METAL-CLAD SWITCHGEAR

When you consider furnaces, think

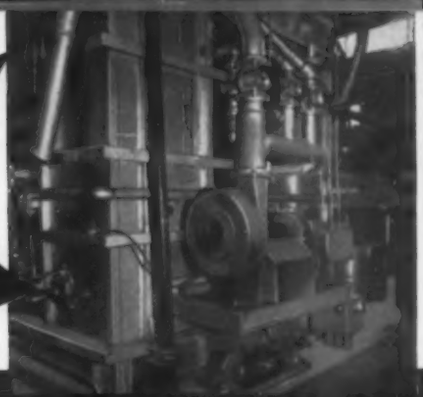
Battery of F.E.I. Annealing Furnaces in a large eastern steel mill. F.E.I. furnaces are completely automatic . . . easy to operate . . . maintenance practically nil . . . minimum critical materials required.

These furnaces are controlled automatically from a single Remote Control Room, as pictured below.

F.E.I. Builds

Open Hearth Furnaces,
Soaking Pits,
Continuous Reheating Furnaces,
Forging Furnaces,
Annealing and Normalizing Furnaces,
Galvanizing Furnaces,
Complete Heating Lines for all kinds of armament—guns, armor plate, shells, etc.

# of F·E·I· first



View of Blower that activates F.E.I.'s famous Eductor System.

first THINK OF F.E.I.'s PERFORMANCE RECORD

Actual case histories (like examples cited at bottom of page) prove that all types of F.E.I. furnaces are doing an outstanding job. Leaders of industry, in America and abroad, recognize Furnace Engineers' ability to meet today's urgent requirements for output, while maintaining rigid metallurgical standards for quality.

Typical F.E.I. Burner Assembly — the "heart" of the furnace.

first THINK OF F.E.I.'s ADVANCED HEATING METHODS

Furnace Engineers' patented, automatically controlled combustion system is the talk of the industry. There's a type of burner for every specific need—for every type of fuel. Each offers extreme flexibility, uniform top and bottom temperature, maximum fuel burning capacity for high production and ample turn-down ratios for extended soaking periods. F.E.I. furnaces utilize eductors, controlled atmosphere and other features to increase production economically.

Flue and Burner arrangement of cold-strip sheet annealing furnace.

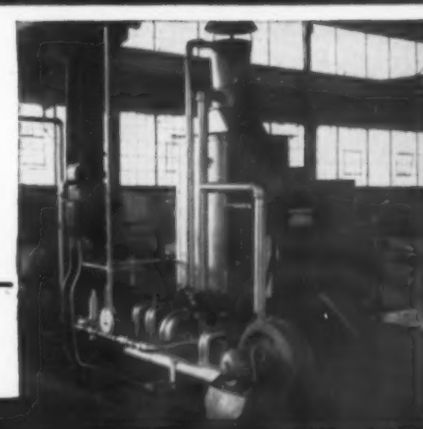
first THINK OF F.E.I.'s "ALL-IN-ONE" SERVICE

Yes, Furnace Engineers' service covers everything—from the preliminary analysis of your specific needs to final operational check-ups. Our staff includes top-flight engineers with up to thirty-five years of experience . . . specialists in the design, construction, installation and operation of all types of industrial furnaces.

Multi-jet Burner and Corrugated Baffle Tile (1 tile removed to show burner).

CASE HISTORIES reveal F.E.I. performance far beyond normal expectations.

A Slab Heating Furnace built for 50 TONS/HOUR actually produced 67 TONS/HOUR; a Hot Dip Galvanizing Line, from which 72 UNITS/HOUR were anticipated, actually turned out 100 UNITS/HOUR; a Pipe Galvanizing Furnace produced 82,060 TONS before replacement of kettle; a Tool Steel Annealing Furnace exceeded specifications of not over 5° F. temperature differential between ends of a 15 ft. bar, with an actual performance of PLUS or MINUS 2° F. These and many other cases merit consideration whether your need is for a new installation or the modernization of existing furnaces.

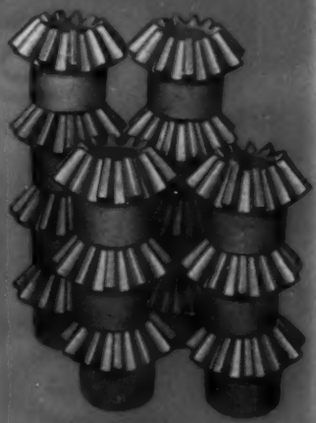


Venturi & Transition for galvanizing furnace (Blower, Valves, Controls, etc.)

Furnace Engineers, Inc.

F.E.I. BUILDING, 1551 W. LIBERTY AVE. PITTSBURGH 16, PA.

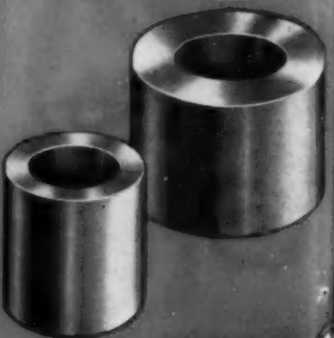
Versatile? That's FARRELL-CHEEK



FOUR decades of broad experience in the field of producing the finest of highly diversified steel castings has given Farrell-Cheek a wide reputation for versatility. The skills and experiences which have come with forty years of diligent experimentation, research, and development, make Farrell-Cheek the logical source for long-wearing, extremely durable cast steel parts . . . standard or special design . . . either new, or for replacement.

Farrell-Cheek parts are made from carefully selected special steels. Farrell's Carbon Steels, Farrell's "85," and Farrell's Hard Edge, have all been developed for specific qualities which will give parts maximum strength and resistance to wear. Hard Edge has an affinity for depth penetration which can be controlled from 1/8" to 1/4" and permits great durability to be combined with fine machining properties. Farrell's "85," made in either carbon, vanadium, copper, nickel, or chrome combinations with manganese-molybdenum, can be hardened and toughened throughout, and provides superb qualities of toughness, rigidity, and wear resistance.

The fine physical properties of Farrell's cast steels, combined with a wealth of experience in the design and production of a tremendous variety of small to medium castings, makes the Farrell-Cheek name your choice for the procurement of your needs . . . the one source for the best . . . with the experience and ability to give you what you want.



FARRELL-CHEEK STEEL CO.

MANUFACTURERS OF HIGHEST QUALITY ELECTRIC FURNACE CARBON AND ALLOY STEEL CASTINGS

FARRELL'S CARBON STEEL CASTINGS
FARRELL'S HARD EDGE STEEL CASTINGS
FARRELL'S "85" STEEL CASTINGS

RAILROAD CASTINGS Locomotive and Car R. R. Specialty Castings.

ELEVATOR, CONVEYOR PARTS Sprockets, Traction Wheels, Chains, Buckets, Rollers, Idlers.

BUSHINGS Carbon and Alloy Steels Machined, Hardened, Ground.

CRANE WHEELS Overhead, Gantry, Monorail, Ingot Car, Charging Machine.

GEARS AND PINIONS "True Tooth" Gears and Pinions, Sheaves and Wheels.

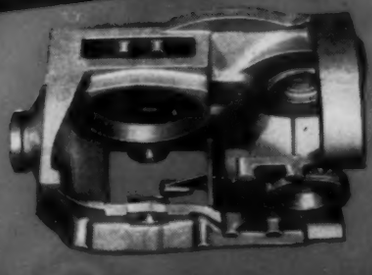
SPECIALIZED CASTINGS Light Section Castings.

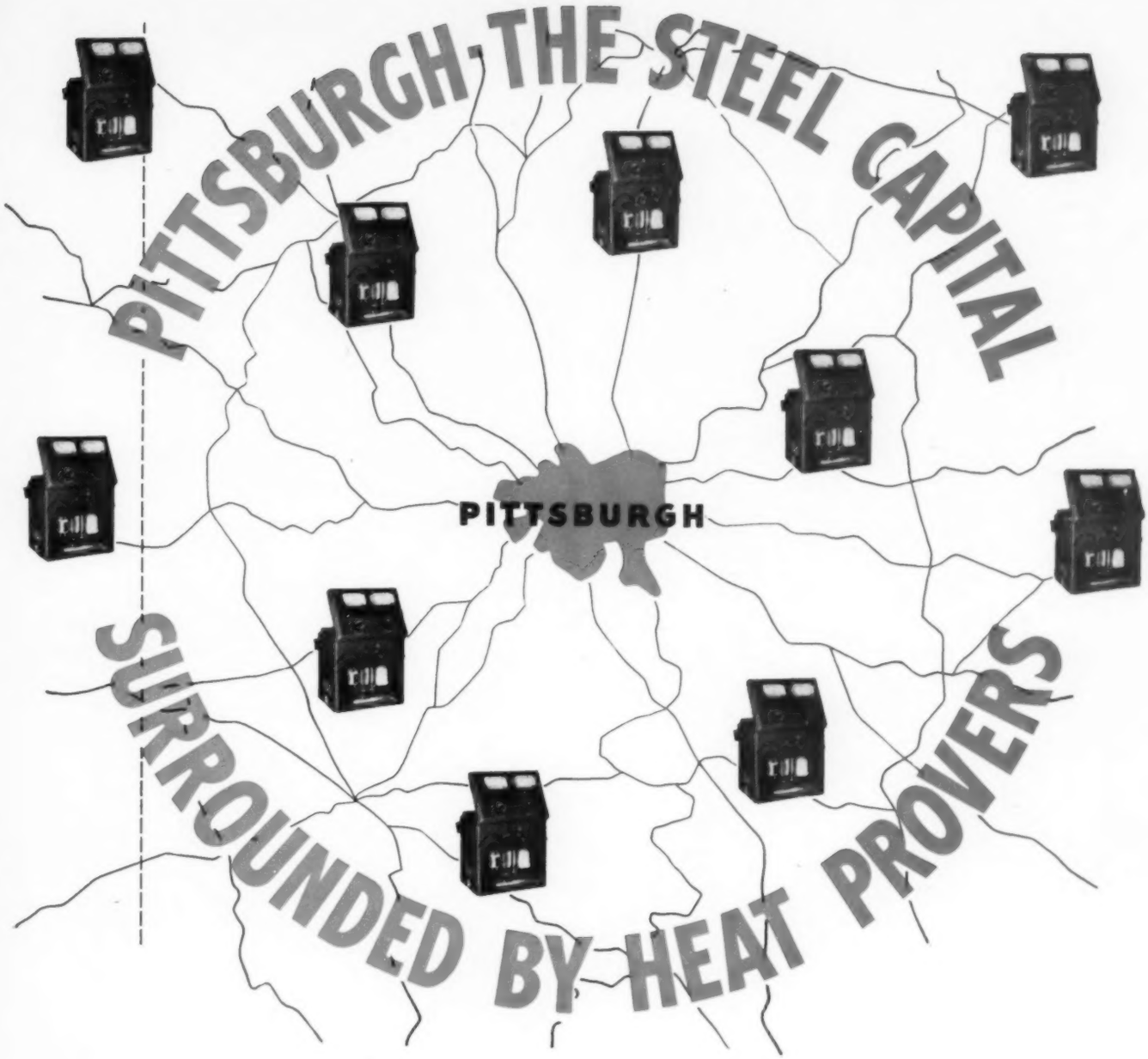
STOKER PARTS Feed Screws, Furnace Tools, Flanged Pipe, etc.

HEAVY HARDWARE Wire Rope Fittings, Choker Hooks, Bar Benders, Cutters.

SANDUSKY, OHIO U.S.A.

YOUR INQUIRY WILL PROMPTLY BRING DETAILED INFORMATION PERTAINING TO ANY OF THE ABOVE FARRELL-CHEEK PRODUCTS





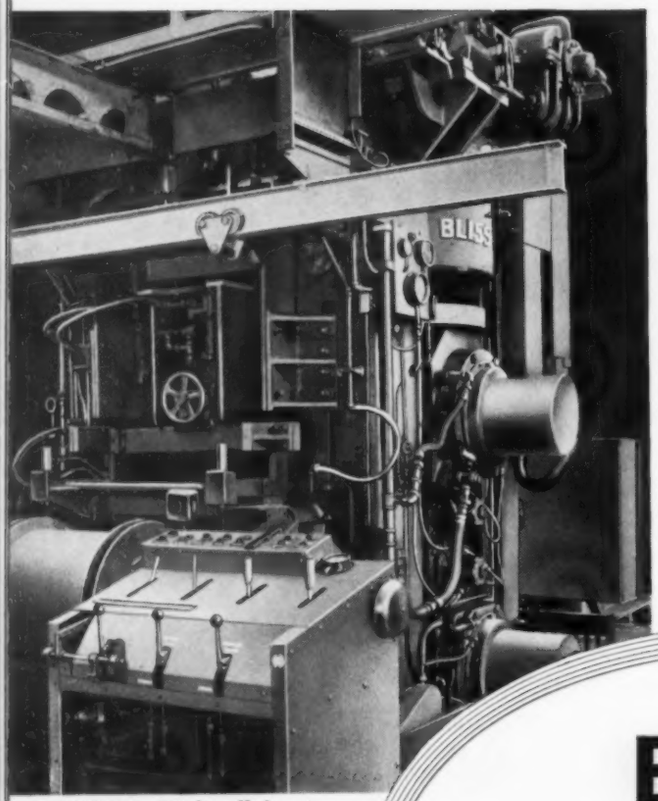
When your eye is on Pittsburgh—and three dozen towns in its orbit—you're spotting scores of furnace operations regularly checked by Cities Service Heat Provers. Here, where they know all kinds of furnace instruments, and where high efficiency is most urgent today, the application of Heat Provers by Cities Service is increasingly valued.

It takes the Heat Prover to read simultaneously for oxygen and combustibles, measured direct by actual gas analysis. And the Heat Prover's continuous rapid sampling reveals effects of furnace adjustments at once. The Heat Prover frees you of maintenance too, because it's *not an instrument you buy, but a Service we supply*. Learn how it can raise productivity for you . . . in iron, steel, ceramics, glass, cement or any other furnace operation. Write CITIES SERVICE OIL COMPANY, Dept. C17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Bliss Rolling Mills Meet the Test of Severe Usage at Alcoa



42" Four-High mill showing cone type payoff.

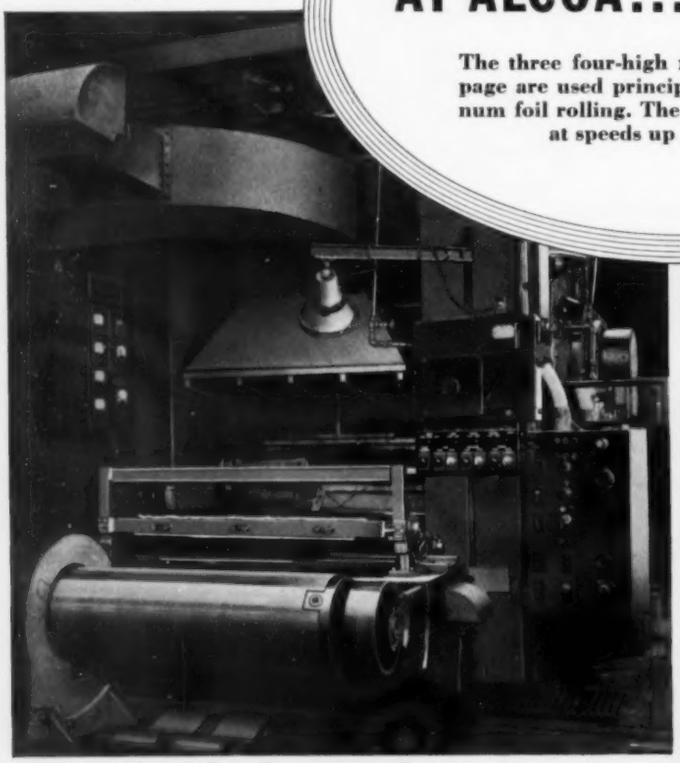
Whether it's strip, sheet or foil, hot or cold working, you will find Bliss Rolling Mills and Accessories meeting exacting standards throughout the various plants of the Aluminum Company of America. Illustrations of various four-high mills installed in Alcoa plants at Edgewater, New Jersey and Davenport, Iowa are shown on these pages.

With non-ferrous and ferrous metal producers alike, Bliss Rolling Mill engineers concentrate on the design of equipment, combining the speeds and controls required with the rigidity and accessibility necessary for long trouble-free service.

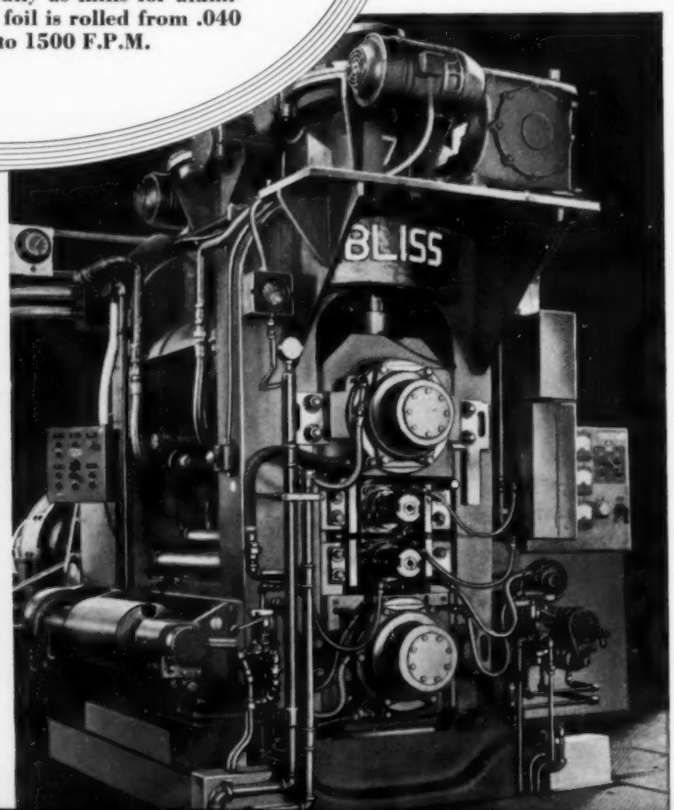
For the engineered refinements that make for maximum production—for the rugged rolling mill performance you want, put your problem up to Bliss. You'll get the same keen counsel that's made Bliss the first name in presses for more than 90 years.

BLISS
AT ALCOA...EDGEWATER

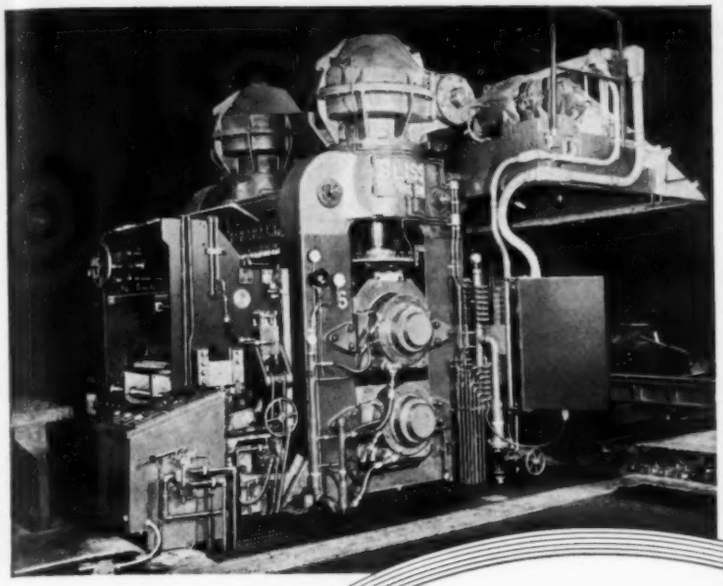
The three four-high mills illustrated on this page are used principally as mills for aluminum foil rolling. The foil is rolled from .040 at speeds up to 1500 F.P.M.



60" Four-High mill with tension reel, stripper, coil buggy and outboard bearing.

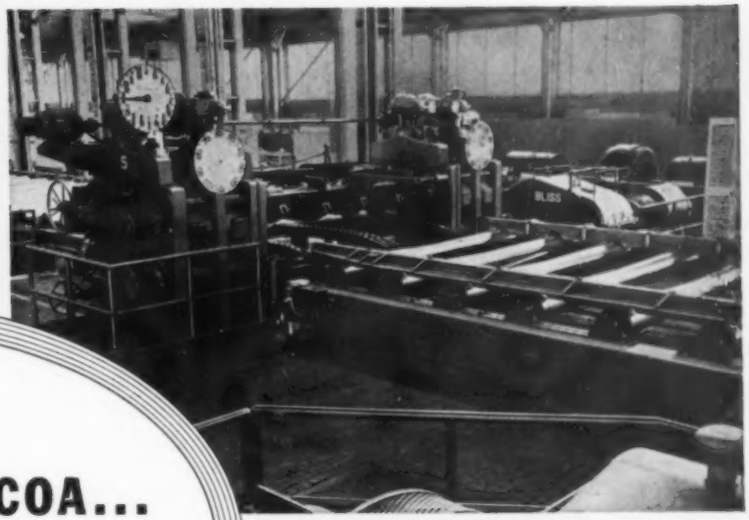


34" Four-High mill, one of four installed.



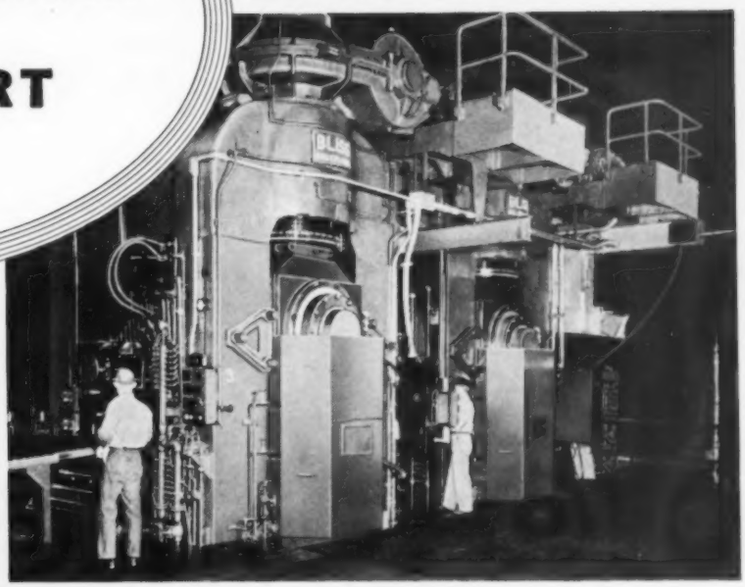
60" Single-Stand Two-High mill at Davenport, used extensively for rolling specialty sheets and temper pass rolling on the lighter gages. A Bliss 48" Single-Stand Two-High mill is also installed at Davenport.

Bliss side trimmer and scrap chopper in Davenport's hot mill line capable of trimming stock up to 1" thick by 136" wide.



BLISS AT ALCOA...

DAVENPORT



72" Two-Stand Four-High mill at Davenport, used to roll a hard-alloy aluminum. Reductions generally run from .144 to .065.

72" Single-Stand Four-High mill at Davenport, a general-purpose reduction mill. Reductions have been as much as 60%, although 50% is considered average.

E. W. Bliss Company

General Office: Canton, Ohio

Rolling Mill Division, Salem Ohio

Presses, Rolling Mills; Special Machinery

LINDE'S News of Metalworking

Braze-Welded Repair Saves Six Months' Production Time

When the base of a 5-ton alligator shear cracked in service, early return to normal plant operation appeared hopeless. Delivery of a new shear was six months away . . . cost $1,800.

But LINDE service engineers suggested braze-welding. Within a few days the shear was back in service—permanently repaired at a cost of only $355. This single braze-welding job saved the manufacturer $1,445 and six months of valuable production time.

Similar typical savings account for widespread industrial acceptance of braze-welding as a quick, easy way to join steel, cast iron, malleable iron, and many dissimilar metals. And routine repairs by braze-welding are often made without dismantling machines. Shut-down time is always kept to a minimum.

Why not save the cost, delivery, and installation time required for that new part? Put the old one back on the job with braze-welding.

Braze-welding is only one of many time- and moneysaving LINDE methods for making, cutting, joining, treating, and forming metals. For further information, call or write our nearest office today.

What's News

► One steel company has found their OXWELD C-60 Cutting Blowpipe so effective in reducing large pieces of scrap that they are now purchasing quantities of large-size scrap to process themselves.

► Saran and polystyrene, previously resistant to speedy pulverization, are now being successfully ground by LINDE'S new liquid nitrogen pulverization method. . . . Efficiency is such that the new process pulverizes some previously difficult-to-grind materials at rates over 700 lb. per hr.— using small mill hammers.

► Magnesium hydraulic systems for landing gears were formerly discarded at an airplane shop when pinhole leaks appeared. Now, thanks to HELIARC welding they're repaired at a saving of $500 each.

"LINDE" SERVICE DOESN'T COST — IT PAYS!

LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

"Irreplaceable" Cylinder Back at Work in 20 Hours

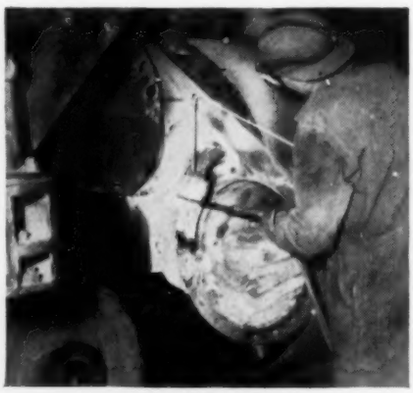
It looked as if "old faithful" was headed for the scrap pile when overworked pistons snapped and cracked the cylinder of a 1904 model railroad locomotive. To replace the cylinder would have been next to impossible. But braze-welding had "old faithful" back at its lumber mill job in only 20 hours.

Repairs were made without dismantling. After the crack was prepared for welding, the cylinder was covered with asbestos paper and preheated. Then the crack was welded, and the cylinder rebored. Total preheating and welding time was 13 hours.

Repairs cost only $138, including materials, labor, and overhead. Even if the cylinder could have been replaced—at a cost over $4,000—the locomotive would have been idle many months instead of the few hours required to make the repair.

Rapid repair of unavailable or hard-to-get parts is a natural job for braze-welding. Try it yourself, next time you're bothered with a troublesome replacement problem.

Replacement of this $1,400 ring gear would have taken more than six months. Braze-welding at half the cost rebuilt badly worn teeth and restored the gear to service in just a few days.

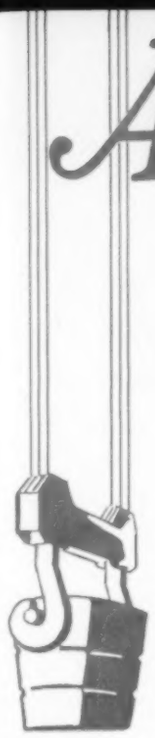


Braze-welding this locomotive cylinder without dismantling saved a lumber company more than $4,000. On special jobs like this, LINDE service and supervision assures success.

The terms "Heliarc," "Linde," and "Oxweld" are registered trade-marks of Union Carbide and Carbon Corporation.

Alliance 12-ton

OPEN HEARTH CHARGING MACHINE



● This photograph shows a new low-type 12-ton Alliance Charging Machine recently installed in one of the world's largest and most efficient steel producing plants.

This machine, designed and built by Alliance, world's largest builder of big cranes, has an unusually large number of exclusive new features that make charging operations easier and less costly.

For instance there's a —

Spring-loaded pitman that always keeps the trolley on the rails, providing ample traction for pushing scrap into the furnace and for the retraction of peel and box.

Box section bridge girder made of welded I-beams reinforced by diaphragms spaced at 3-ft. intervals.

Full length machinery deck plate located between the main and outrigger girders provides lateral stiffness and a safety platform for maintenance.

Stabilized, shock-absorbing wheels are held in contact with both upper and lower rails by means of springs, which reduces shock to the operator.

Four track-equalizer trucks, located at the corners on eight-wheel bridges, compensate for any irregularities in the track.

Finger-tip control provided by new type hydraulic lock rod.

All gears (including track wheel gears) are fully enclosed and run in oil.

These and many other Alliance features result in smoother overall plant operation.

Whenever it's a problem of handling heavy materials of any kind at your plant, contact Alliance . . . the world's most respected builder of big cranes.

THE Alliance MACHINE COMPANY

World's largest builders of world's largest cranes

MAIN OFFICE
ALLIANCE, OHIO • PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

"You mean a

loose slot stick

stopped that

whole train?"

Certainly—but the report will say: "Motor failure was caused by a ground in the armature coil, 1 inch in from the end of the slot, pinion end." Overlooked in the report is the tiny slot stick, or wedge, which was made a couple of thousandths off size, or which was off a hair's breadth because of shrinkage. From it, coil vibration developed. Soon, a ground—motor failure—and *the train couldn't make the grade.* All over the world—in mines, in industry, in electric utilities—production trains can't make the grade because of "minor" failures deep in the bowels of motors and generators. National has demonstrated that the frequency of such "minor" failures can be drastically reduced. How? By insisting that every component which National supplies or installs must fit the particular job *that* motor or generator has to do—by refusing to be bound by standards set at some time in the obsolete past to fit general usage. We invite you to check the National record. We're proud of it.

NATIONAL ELECTRIC COIL COMPANY

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

steady, high production from BIRDSBORO ROLLS

PEAK PRODUCTION to meet today's crowded steel rolling schedules starts in the foundry where the rolls are engineered. It is there that dependable roll performance on the job is assured through proper roll design, painstaking analysis control, plus pioneering leadership in the development of ever finer rolls. That's one of the reasons why users of Birdsboro rolls are turning out alloy, stainless and high speed steels in greater volume at lowest cost per ton.

One example of Birdsboro's constant roll research is found in Curoloy copper grain rolls. With their special analyses developed and patented by Birdsboro, they provide you with a unique combination of physicals to keep production up on a wide variety of jobs. In use in many mills, Curoloy is further proof of how you can depend on Birdsboro for help in the solution of your roll problems. Next time, discuss your individual problems with a Birdsboro engineer.

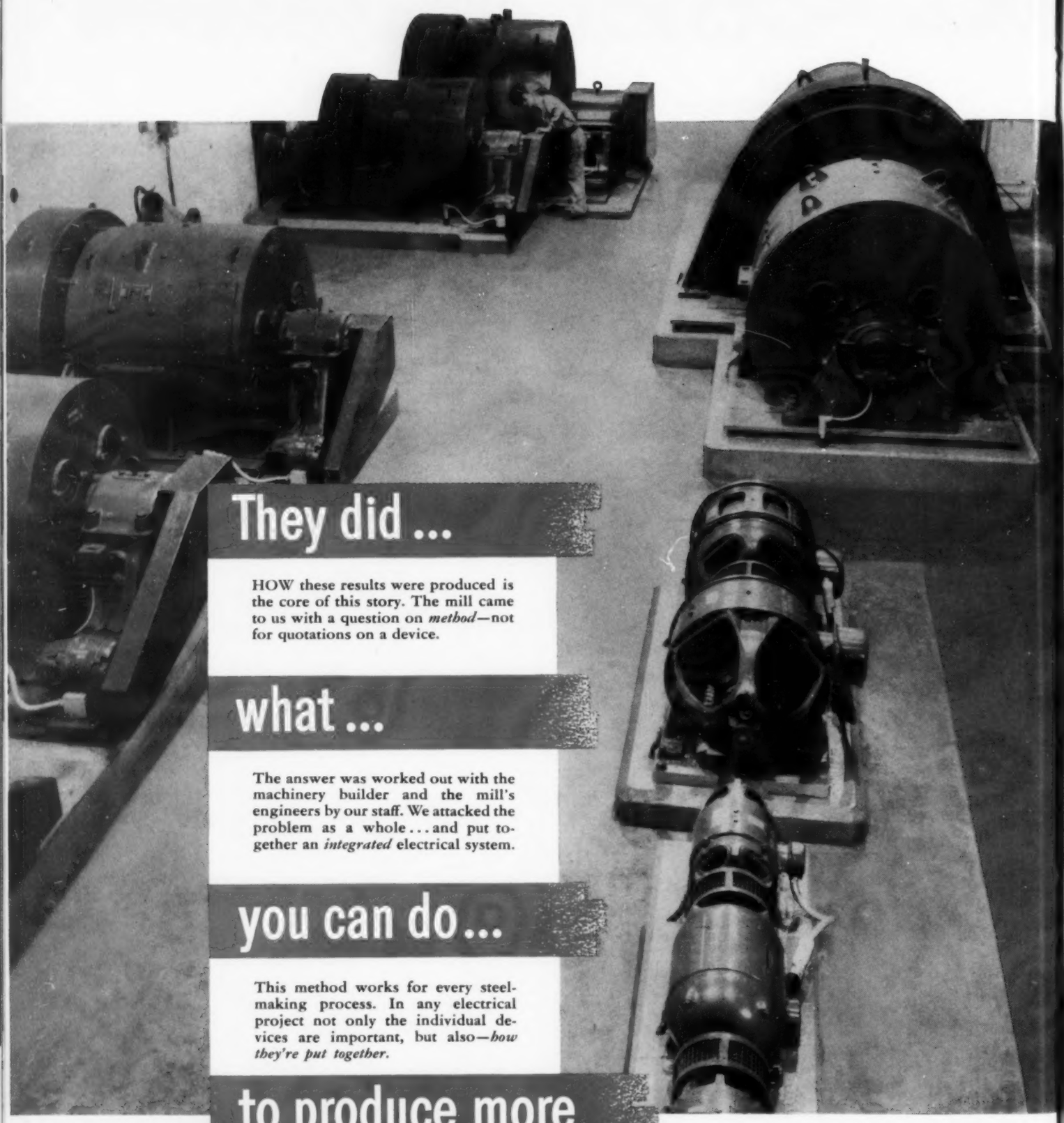
R-7-52

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

Offices in
BIRDSBORO, PA.
AND PITTSBURGH, PA.

ROLLS

Designers and Builders of:
Rolls • Crushing Machinery • Steel Mill Machinery
Hydraulic Presses • Special Machinery • Steel Castings



They did ...

HOW these results were produced is the core of this story. The mill came to us with a question on *method*—not for quotations on a device.

what ...

The answer was worked out with the machinery builder and the mill's engineers by our staff. We attacked the problem as a whole ... and put together an *integrated* electrical system.

you can do ...

This method works for every steelmaking process. In any electrical project not only the individual devices are important, but also—*how they're put together.*

to produce more

Developing integrated electrical systems that help raise steel production has been one of our major activities for the past 50 years. Your Westinghouse office is a good place to go when you have a job for electricity.

This Westinghouse equipment produced the outstanding results. At left are drive motors; in center the M-G sets which supply them power. At far right the d-c switchgear, and in foreground the Rototrol regulator and M-G set exciter.

New Drive boosts rod-mill output and quality

Here's a new rod mill that produces a high output of quality steel by eliminating the rod "squeeze and stretch" problem. Basic secret: an advanced Westinghouse electronically-controlled drive that maintains roll speed with hairline accuracy.

Precisely maintains roll speed

When a billet-end enters or leaves a roll-stand, the speed of the driving motor stays constant—*despite the change in motor load.* Thus, there's no danger of the steel stretching or looping between stands which can cause distortions that no amount of subsequent rolling can completely eliminate.

More production in less space

The precise speed control of the Westinghouse drive permits the mill to run as fast as 3,900 fpm—even though the roll-stands are spaced at only 92″ intervals. This makes a neat, compact layout that turns out high production in a small amount of space. The drive has an over-all speed range of 4 to 1 so that a wide range of sizes and types can be processed.

Needs practically no attention

Once set, the drive runs for an entire shift with practically no attention from the operator. It's easy to maintain, too. Motors, M-G sets, exciters, controls, etc., are of well-known Westinghouse construction. The electronic speed regulator is built in sectional subassemblies for easy maintenance.

Call Westinghouse early on every job

Your next job can benefit from the years of steel mill experience that Westinghouse brings to every steel mill project. It pays to call Westinghouse early on *every* job. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94882

YOU CAN BE SURE... IF IT'S

Westinghouse

EQUIPMENT FOR STEEL PRODUCTION

plan for the best...

If you are seeking more efficient anti-friction performance, you can profit by Torrington's experience and unbiased counsel.

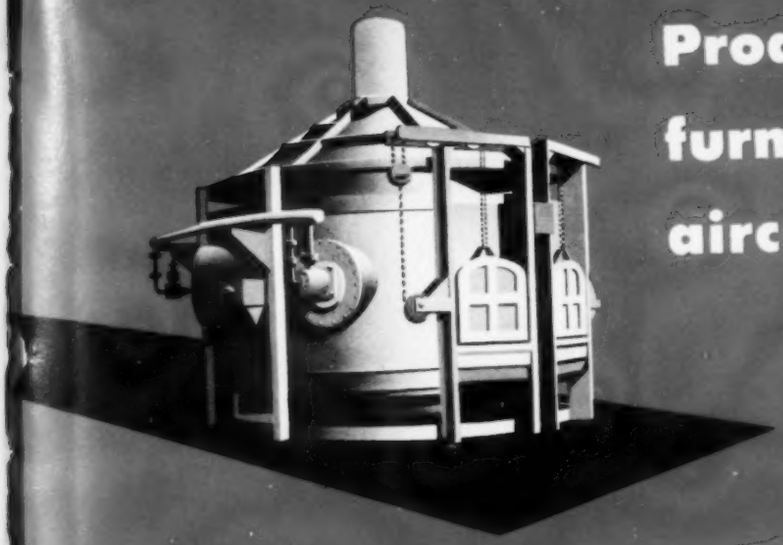
For example, Torrington makes Spherical Roller, Tapered Roller, Straight Roller Bearings and Needle Bearings as well as Ball Bearings and other types. Therefore, our engineers are able to recommend *the* type or combination of types best suited to your design and operating requirements.

Next time you are planning a new design, call in a Torrington engineer. He will be happy to work with you.

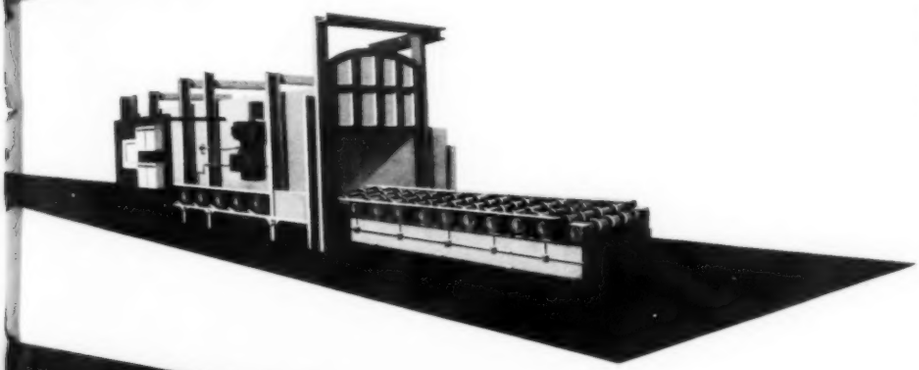
THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

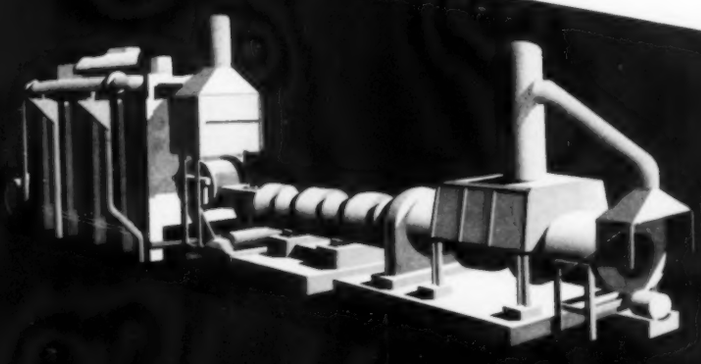
Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Roller



Production heating furnaces for guns, shells, aircraft or engine parts



Prominent among the many services offered by Salem-Brosius to the metal-working industry, both ferrous and non-ferrous, is the design and construction of heating and heat-treating furnaces specially adapted to defense production. Whether you produce aircraft, ordnance, armor, engine parts, or a multitude of similar and associated items, the experienced staff at the Salem Engineering Division is prepared to help you . . . to build furnaces for you that cut cost and add production. Remember, if you have a problem which involves the use of furnaces, blast furnace equipment, or charging and manipulating machines, it will pay you to call on highly diversified Salem-Brosius today.



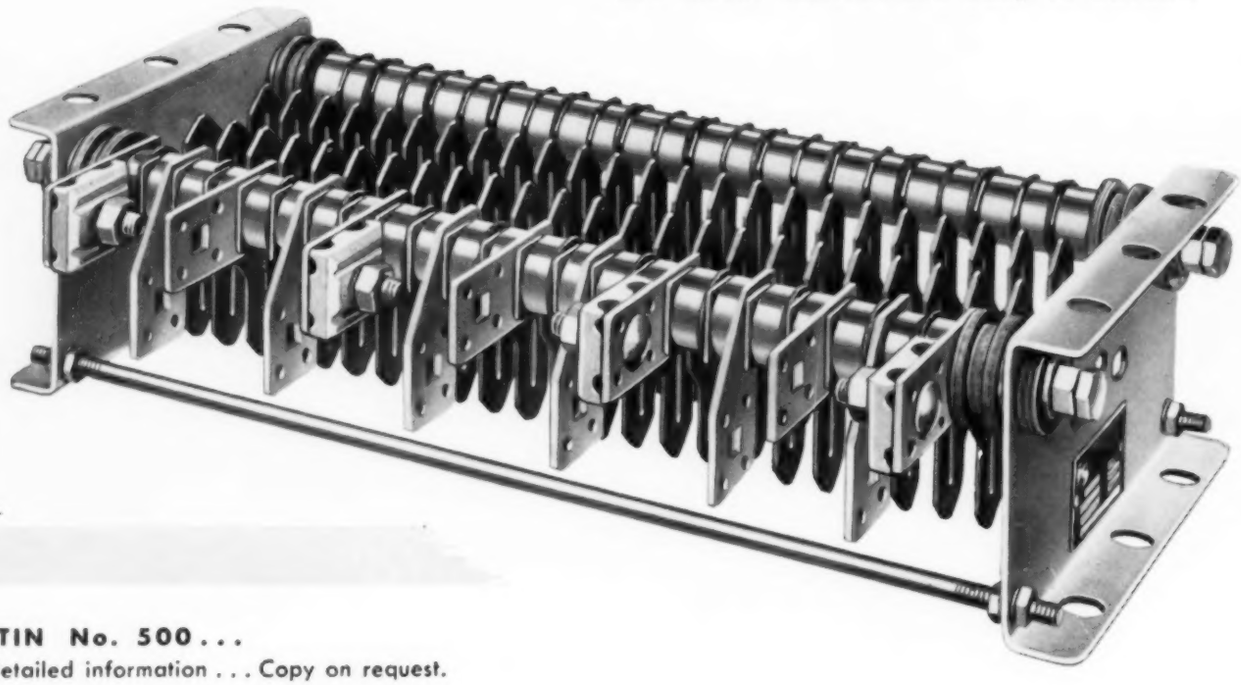
SALEM-BROSIUS, INC.

SALEM ENGINEERING DIVISION, SALEM, OHIO

BROSIUS DIVISION, PITTSBURGH 15, PA.

P-G *Grids* ASSURE ACCURATE MOTOR CONTROL!

Because the resistance grids used for P-G STEEL GRID RESISTORS are produced in a great number of specific resistance values. Thus the varied current requirements for accurate motor control are easy to obtain.

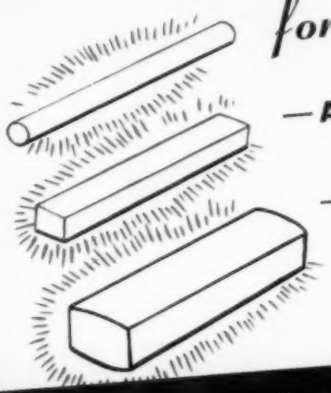


BULLETIN No. 500...
Gives detailed information . . . Copy on request.

Flexibility in meeting current requirements, enables P-G Steel Grid Resistors to have *both* correct ohmic values as well as required capacities for each application. Naturally, this abitity assures *accurate motor control*. Specify P-G for your next application.

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
221 WEST THIRD STREET, CINCINNATI 2, OHIO

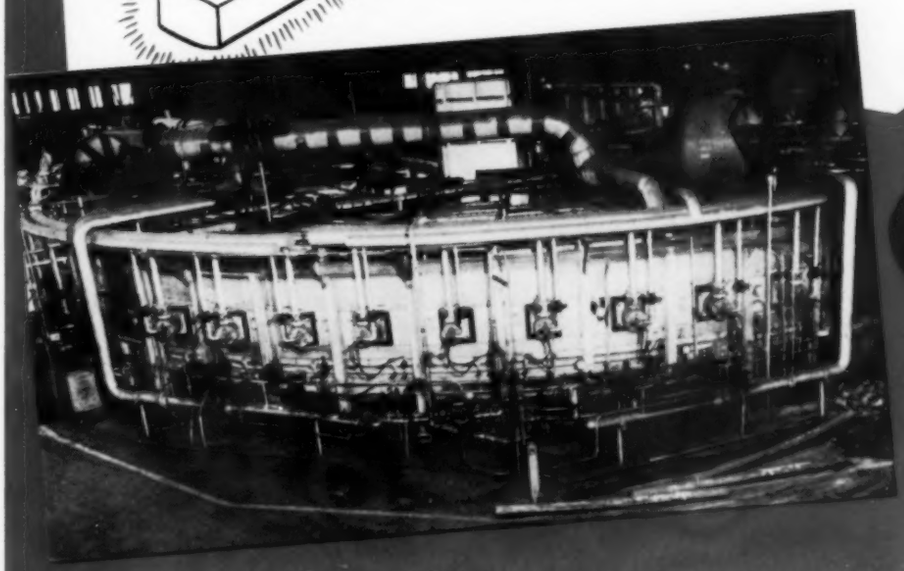


for **HEATING BARS—BILLETS—BLOOMS**

—AUTOMATIC CONTROL OF COMPLETE HEATING CYCLE

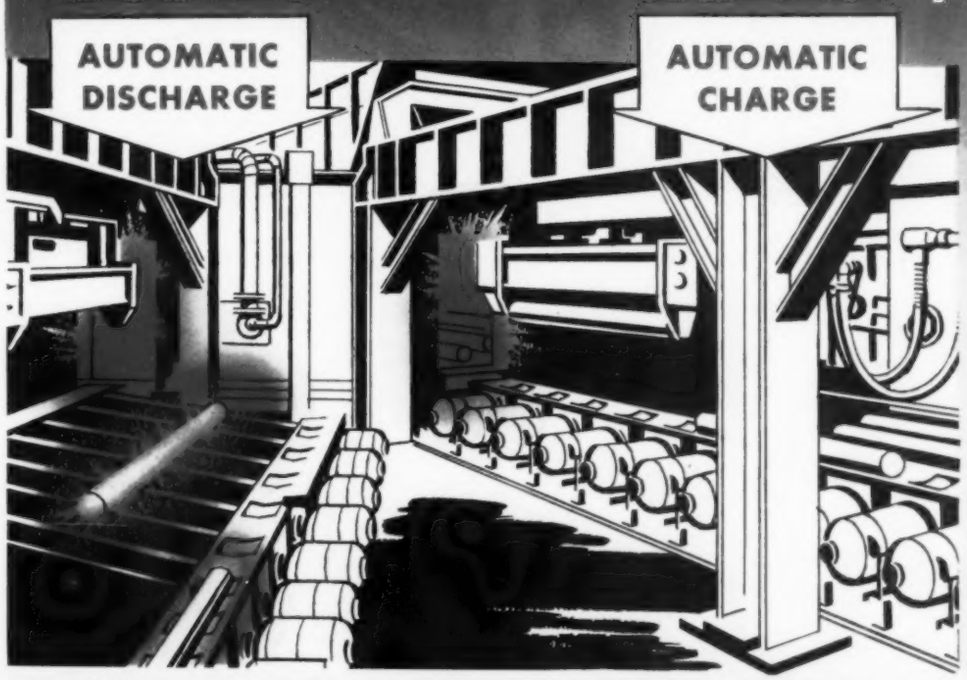
—AUTOMATIC CHARGING AND DISCHARGING

—FUEL SAVINGS UP TO 36%



Hagan

ROTARY HEARTH FURNACES



HAGAN Modern Firing Methods promote greater uniformity, produce less scale and give lower fuel consumption.

HAGAN Charger and Discharger grips stock endwise, giving greater hearth coverage and greater tonnage from a given furnace size. Grips can be adjusted within a minute for changes in length.

HAGAN Station Switch permits automatic charging of new stock on different heating cycle while stock is still being unloaded on previous setting, thereby decreasing mill delay.

HAGAN Rotary's completely automatic operation permits constant duplication of heating patterns, producing maximum yield with minimum heating cost.

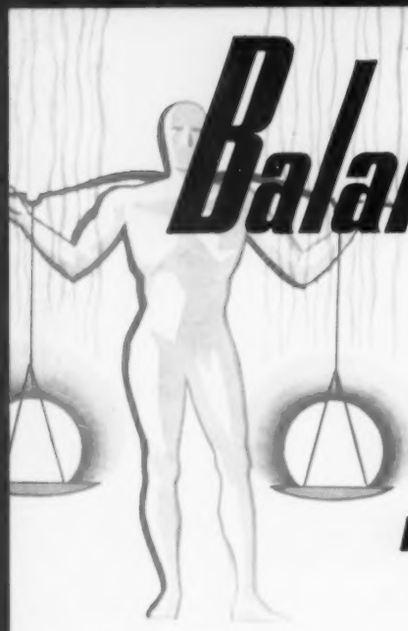
Check First with Hagan FOR ADVANCED ENGINEERING IN INDUSTRIAL FURNACE APPLICATIONS

GEORGE J. HAGAN COMPANY

2402 East Carson Street

PITTSBURGH 3, PENNA.

CHICAGO DETROIT FT. WAYNE, INDIANA



Balanced Heat Flow IN 'SURFACE' CO

VOLUME PRODUCTION AND CLOSELY CONTROLLED ANNEALING, UNHEARD OF IN PAST EMERGENCIES, ARE POSSIBLE FOR TODAY'S DEFENSE AND CIVILIAN REQUIREMENTS.

Four 'Surface' developments, used together in a balanced heat transfer system, *are breaking records for top speed and true quality in annealing.*

'Surface' harnesses heat for the steel industry. Hundreds of 'Surface' annealing covers and bases in America's leading steel mills employ the components shown below to produce thousands of tons of bright-annealed flat rolled steel each hour. They are operating in every important steel mill center from coast to coast.

Shown here is a battery of 'Surface' radiant tube coil annealing covers of the rectangular double-row type utilizing a protective controlled atmosphere for bright annealing rolled steel sheets.

1 **COIL SEPARATOR** ● Simple, rugged construction balances convection heating and cooling. Directs rapidly circulated heating and cooling gases to ends of coil laminations. This utilizes solid metal heat transfer, rather than conduction through laminations.

2 **HIGH POWERED BASE FAN** ● Power input is many times greater than used formerly. Incorporates a unique 'Surface' designed method of sealing annealing atmospheres against differential pressures.

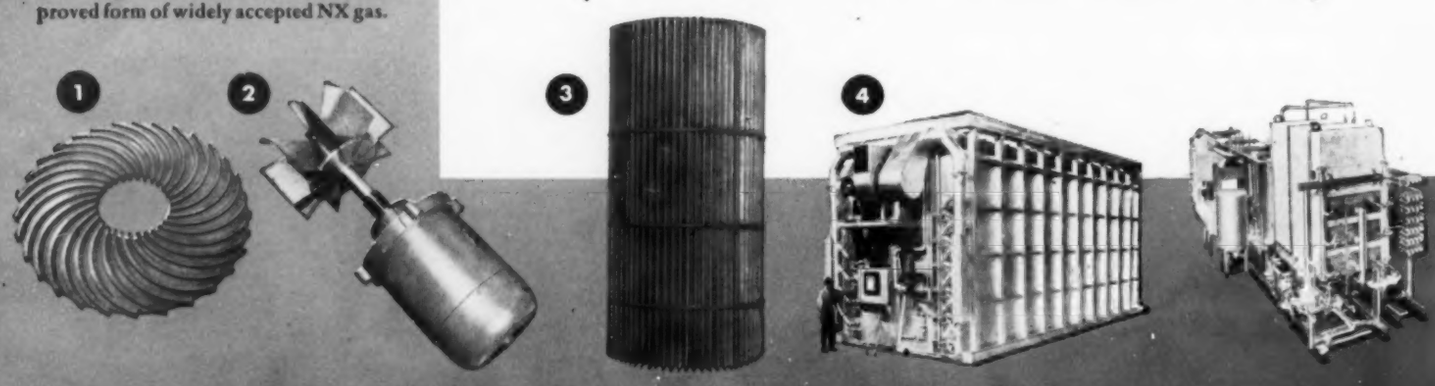
3 **CORRUGATED INNER COVER** ● Deep corrugations absorb and transfer heat to circulated gases within the inner cover during heating cycle and speed cooling of the charge by reasons of the large area exposed.

4 **RADIANT TUBE HEATING COVER** ● Stepped-up, useful heat input of 'Surface' radiant tubes balances the fast heat absorption rate of the new deep-corrugated inner covers and fast heat transfer of base fans and coil separators.

Here's an additional 'Surface' development that assures "Quality Control" of heat treated products.

HNX ANNEALING ATMOSPHERE GENERATOR ● Non-explosive HNX gas provides complete surface protection for steel in 'Surface' cover-type annealing furnaces. HNX is an improved form of widely accepted NX gas.

Submit your heating and heat treat problems to 'Surface' engineers for heat-engineered recommendations and latest equipment.



COVERS...RESULTS IN FASTER AND BETTER ANNEALING

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON

STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

'Surface' SERVES THE STEEL INDUSTRY

One-Way Fired Soaking Pits • Billet Reheating Furnaces • Slab Heating Furnaces • Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces • Controlled Atmosphere Annealing Covers for Wire and Rod • Controlled Atmosphere Annealing Covers for Coil and Sheets • Continuous Furnaces for Heat Treatment of Steel Plate • Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock • Continuous Type Bright Annealing and Normalizing Furnaces • Prepared Gas Atmosphere Generating Equipment • Pit Type Convection Furnaces for Rod Annealing • Stress Relief Furnaces • Wire Patenting Furnaces

Photograph Courtesy of Weirton Steel Company, Division of National Steel Corporation

● ● ● ● This is a suspended basic end in the world's largest open-hearth furnace. Such construction was pioneered by Grefco with its STEELKLAD basic brick. In the picture you'll find STEELKLAD in the end wall, the sidewalls and the port roof.

STEELKLAD is a patented, unburned basic brick, permanently jacketed in a steel shell, with the metal an integral part of the brick. A STEELKLAD wall rapidly becomes a tight, monolithic structure in service. It will deliver the longest possible life under the most severe conditions.

Nothing Could Be More Basic!

GENERAL REFRACTORIES

GENERAL REFRACTORIES COMPANY
PHILADELPHIA

Grefco's STEELKLAD is resistant to spalling, has low thermal conductivity, high hot strength and great accuracy to specified dimensions.

With products like these, General Refractories is playing an important part in providing the steel industry with a complete refractories service. 43 mines, 29 plants, 18 sales offices, 200 distributing agencies—and the world's most modern research laboratories—are helping to meet industry's ever-growing demand for steel!

A Complete Refractories Service

You'll be glad you checked BRISTOL'S DYNAMASTER

Electronic temperature recorders and controllers

A high-speed, accurate electronic brain to measure, record, and control d-c voltage, d-c current, resistance, capacitance—or any variable that can be converted into those quantities.

The continuous-balancing circuit responds to minute changes *instantly*.

Available as a self-balancing bridge or potentiometer, the Dynamaster is a versatile, dependable, trouble-free measuring instrument.

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CHECK THESE ✓ practical features

Simple design for long, trouble-free operation

Little or no maintenance

Electronic component uses vacuum tubes available from any radio supply house

Full-scale pen travel in 7, 3, or ⅔ seconds

Chart speeds from ¾ in. per hour to 7200 in. per hour

Multipoint recorders up to 16 points

Same amplifier used on all Dynamaster models . . . can be removed and replaced with nothing but a screwdriver

Periodic automatic standardization on potentiometer models

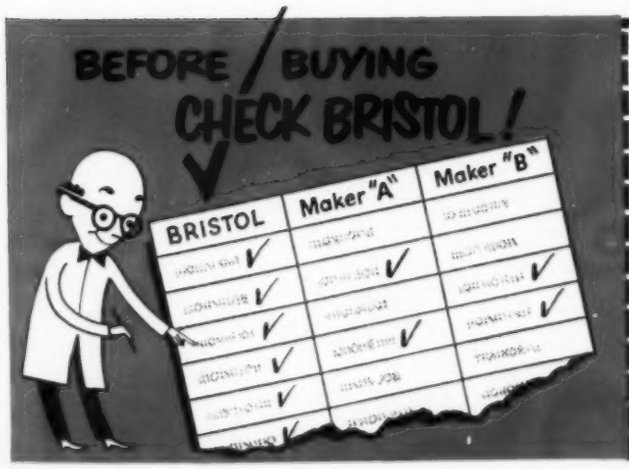
Exceptionally unaffected by stray currents (1000 to 1 discrimination)

Practically immune to vibration or shock

FOR MORE INFORMATION *on how Dynamaster can solve your measurement problems, use the coupon to send for Catalog No. P1245.*

COMPANIES LIKE THESE *are using Dynamasters*

North American Cyanamid Limited
Jones & Laughlin Steel Corporation
Raybestos-Manhattan, Inc. Manhattan Rubber Division
Consolidated Edison Co. of New York, Inc.
Friez Instrument Division, Bendix Aviation Corp.
Scovill Manufacturing Company
Pratt & Whitney Division, Niles-Bement-Pond Co.
International Harvester Company
Westinghouse Electric Corporation
The Johns Hopkins University
United Aircraft Corporation
The Sponge Rubber Products Company
Commercial Solvents Corporation
Armstrong Cork Company
United States Steel Company
Collins Radio Company
Baldwin-Lima-Hamilton Corp.
Ruge- de Forrest Company
National Bureau of Standards
Bausch & Lomb Optical Company
Koppers Company, Inc.
Bell Aircraft Corporation
The B. F. Goodrich Company
Boeing Airplane Company
Industrial Nucleonics Corp.
E. I. du Pont de Nemours & Co., Inc.
Automatic Temperature Control Co., Inc.
Swindell-Dressler Corporation
Woods Hole Oceanographic Institution
Jarrell-Ash Company
National Research Corporation



THE BRISTOL COMPANY
123 Bristol Road
Waterbury 20, Conn.

Please send catalog giving details of Dynamaster performance to:

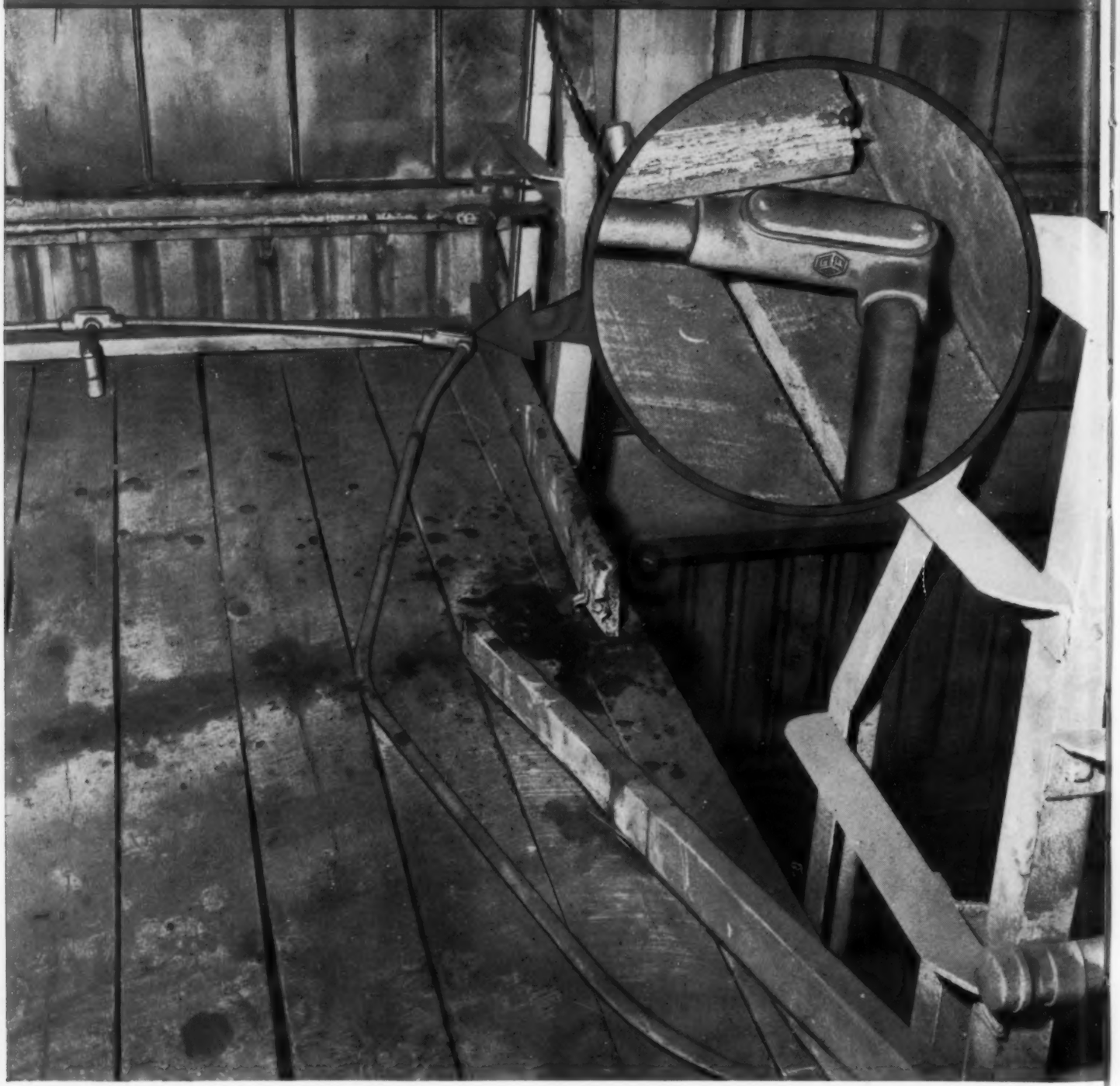
NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

The CONDULET* and rigid



Photograph of an actual case which proves the protective value of CONDULETS and rigid conduit. In an iron foundry, the conduit was accidentally hit by a heavy bucket full of iron, which bent it 21½ inches out of alignment and exerted a heavy strain on the CONDULETS. The CONDULETS withstood the pressure and there was:

NO distortion of the CONDULET. Cover remained tight
NO interruption of electrical service
NO shutdown
NO lost production

*CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

CONDULETS · TRAFFIC SIGNALS

conduit method gives you the
UTMOST PROTECTION
to electrical conductors

To maintain continuous production, it is important that all electrical wiring be protected against accidental mechanical damage which might result in costly shutdowns. Crouse-Hinds cast Feraloy **CONDULETS** and rigid conduit give you the best possible protection to electrical wiring and equipment.

The illustration at the left is an actual photograph of the kind of accident that is not uncommon in industry. Traveling cranes, electric trucks, or other heavy moving equipment frequently strike the electrical system. **CONDULETS** and rigid conduit can protect your electrical installations from damage by such accidents.

Remember . . . it pays to give your electrical system the protection that is only provided by the **CONDULET** and rigid conduit method.

Other Definite advantages

- **MECHANICAL PROTECTION.** Crouse-Hinds sturdy cast Feraloy CONDULETS and rigid conduit provide the best possible protection against accidental damage to the wiring and equipment. Prevents costly shutdowns.
- **FLEXIBILITY.** A modern CONDULET installation provides for growth and changing conditions. CONDULETS with detachable hub plates can be used to make it easy to change circuits or add new ones.
- **ECONOMY.** The installed cost of Crouse-Hinds CONDULETS and rigid conduit compares favorably with other wiring methods. The added advantages make it the really economical method that pays dividends over the years.
- **UNIVERSAL APPLICATION.** You can install galvanized CONDULETS and galvanized rigid conduit under all atmospheric conditions and in all occupancies.
- **CORROSION RESISTING.** Cast Feraloy CONDULETS give the best protection wherever moisture, dust, or corrosive atmospheres are present.
- **QUALITY.** The trademark CONDULET stands for the highest quality, reliability, and long life.
- **VARIETY.** More than 15,000 items are listed in the CONDULET Catalog, including a complete explosion-proof and dust-tight line for use in hazardous locations.

On YOUR next electrical layout, plan to get all the benefits of sturdy cast Feraloy **CONDULETS** and rigid conduit . . . the universal wiring method.

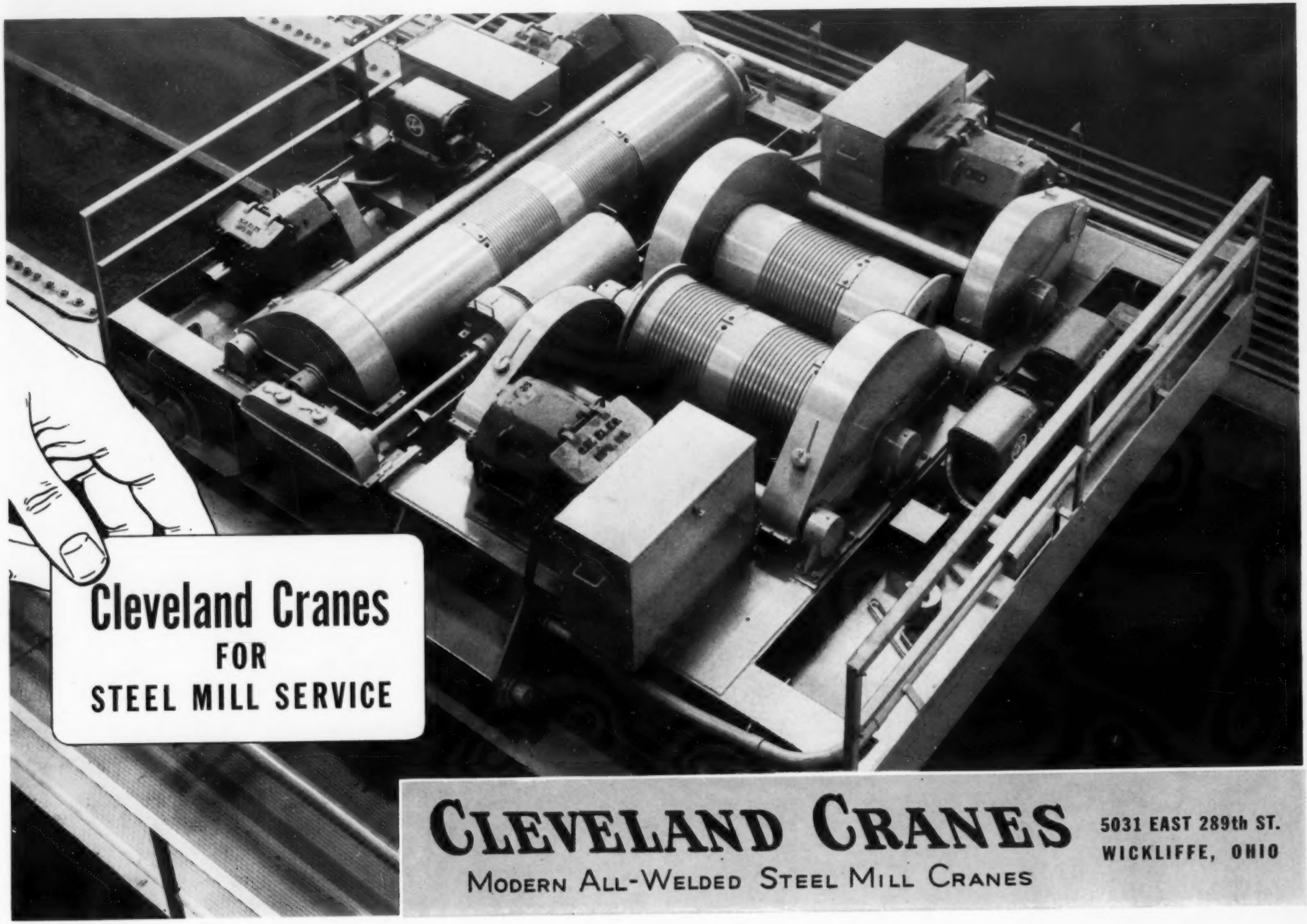
A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Albuquerque—Birmingham—Boston—Buffalo—Chicago—Cincinnati—Cleveland—Dallas—Denver Detroit—Houston—Indianapolis—Kansas City—Los Angeles—Milwaukee—Minneapolis—New York Philadelphia—Pittsburgh—Portland, Ore.—San Francisco—Seattle—St. Louis—Washington.
RESIDENT REPRESENTATIVES: Albany—Atlanta—Baltimore—Charlotte—New Orleans—Richmond, Va.
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

CONDULET
First in the field
STANDARD OF QUALITY

AIRPORT LIGHTING · FLOODLIGHTS


Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

BENJAMIN F. FAIRLESS, in his opening statement before the special panel of the Wage Stabilization Board, said that "a diligent search of the record has disclosed one point upon which I am in complete agreement with Mr. Philip Murray: he has said that he is sorry to be here before this panel; and frankly, so am I."

But rancor and animosity continued to permeate the hearing. Certainly, there was no agreement between Murray and U. S. Steel's Bradford B. Smith, who said that the steelworkers are the "economic royalists" of American workers, "a fact that their leaders readily acknowledge and for which they even claim credit—except when they are asking for still higher pay." Murray called Smith a fool and said his remarks were "reprehensible, filthy, lying, deceiving and beastly." Next day Murray withdrew his personal reflections on Smith and transplanted them to "their rightful proprietors, the industry."

Incidentally, the steel industry payroll for 1951, for 670,700 people was $2,881,170,000, about 21 per cent above 1950, 75 per cent above 1945, and three times that of 1940.

▲

AS March rolls 'round, don't fret about
Your health, or blame your livers.
The thing that ails the most of us
Is income tax day shivers.

▲

STEEL companies' expenditures in 1951 for new equipment and construction, as estimated by the American Iron and Steel Institute, totaled $1,041,000,000, almost double the amount for any previous year. The estimate for 1952 expenditures is $1,300,000,000.

▲

ALTHOUGH we have juggled figures for most of our adult life, and used to be a wiz on a 5-in. slide rule, we must confess complete mystification on the calculations leading to certain TV commercials which claim one deodorant to be 53 per cent more effective than others.

▲

LIFE is just one risk after another. For example, every American boy has a chance to become president when he grows up.

▲

BEFORE we begin to feel prosperous because Americans, representing only 7 per cent of the world's population, have 42 per cent of the world's income, let's look at some other figures. The new federal budget totals about $85,400,000,000. State and local government expenditures are running about $24,000,000,000, making nearly $110,000,000,000, or about $2400 per household—five times the 1939 figure. These expenditures are estimated at approximately 36 per cent of the expected national income.

▲

ACCORDING to the American Iron and Steel Institute, steel production capacity as of January 1, 1952, was as follows:

District	Net tons per year
Eastern	21,722,000
Pittsburgh-Youngstown	42,351,000
Cleveland-Detroit	10,485,000
Chicago	22,259,000
Southern	5,279,000
Western	6,492,000
Total	108,588,000

This total compares with 104,230,000 tons on January 1, 1951.

Blast furnace capacity was 73,782,340 tons per year at the start of 1952, while coke oven capacity was rated at 67,060,240 tons per year.

▲

MAYBE a new field is opening up for metallurgists. Some research is under way at Washington State Institute of Technology on speeding up the aging time of cheese with a trace of manganese.

▲

RUSSIAN steel production for 1951 has been estimated at 32,000,000-34,000,000 tons. Satellite countries produced about 7,000,000 tons. France, Germany, Belgium, Saar, Luxemburg, Austria, Italy, Spain and Sweden produced a total of about 44,500,000 tons.

▲

WE'VE found the champion worrier. He's the guy who, if something happens today, won't have time to worry about it for another two weeks.

▲

NOT content with its record 105,134,553 tons of steel made during 1951, the steel industry in January, 1952, produced a new monthly record of 9,120,000 tons.

▲

SO far as housework is concerned, some women like to do nothing better.

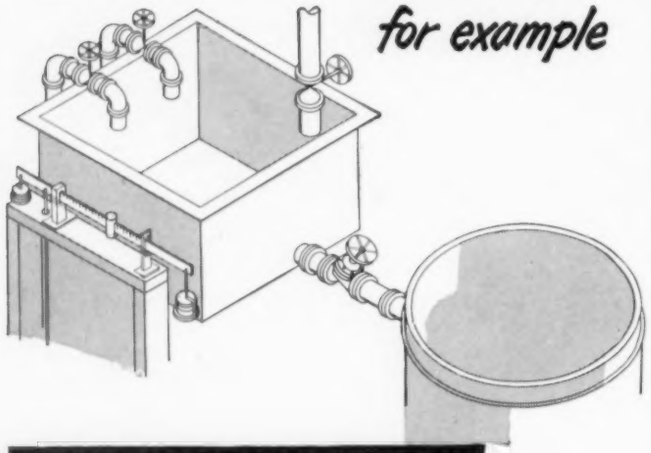
▲

THE recent report of McKinsey & Co., management consultants, is attracting almost as much attention as its celebrated predecessor, the Kinsey report. Differing in subject matter, however, the McKinsey report shows that management and supervisory salaries have not kept up with wages or with inflation. Results for the steel industry are:

	Average pay 1950	Per cent gain, over 1939	Change in purchasing power since 1939, per cent
Top management	$50,000	51	—54
Middle management	12,500	69	—30
Supervisory employees	5,800	93	— 9
Wage-hour employees	3,500	106	+ 3

Found: This Good Alternate for Alloy Valves

on chrome tanning liquor, for example



THE INSTALLATION

At Gutmann & Co., tannery, Chicago, on outlet of open scale tank for mixing highly corrosive basic sulphate of chrome solution used in tanning.

THE HISTORY

This plant had more than its share of trouble with various valves and cocks tried in this service. The highly corrosive solution caused rapid seat wear, leakage, seizing, and constant stuffing box maintenance was necessary. The inoperative valves, and shut-downs for repairs played havoc with the daily schedule of solution mixing.

All this trouble has stopped since the plant installed a Crane No. 1615 Iron Body Packless Diaphragm valve with Neoprene diaphragm, disc insert, and body lining. Even after 2½ years in this severe service, the valve remains absolutely tight; shows no corrosive or erosive effects, no undue mechanical wear, and operates as smoothly as when new. Maintenance cost to date—zero.

VALVE SERVICE RATINGS

SUITABILITY: Neoprene lining good

MAINTENANCE COST: None - inspection only

CORROSION-RESISTANCE: O.K. - no corrosion showing

SERVICE LIFE: In 2½ years - still like new

OPERATING RESULTS: No fluid loss - no valve trouble - no production loss

PRICE: Lower than expected

AVAILABILITY: Regular Crane item

THE VALVE

Crane No. 1615 Packless Diaphragm Valves with Neoprene Lining. Diaphragm acts as bonnet seal only; is not subject to rapid wear. Separate disc with Neoprene insert shuts off flow even should diaphragm fail. Neoprene body lining makes these valves highly suitable for many corrosive fluids, erosive sludges and slurries. Also available unlined. See your Crane Catalog or Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why,

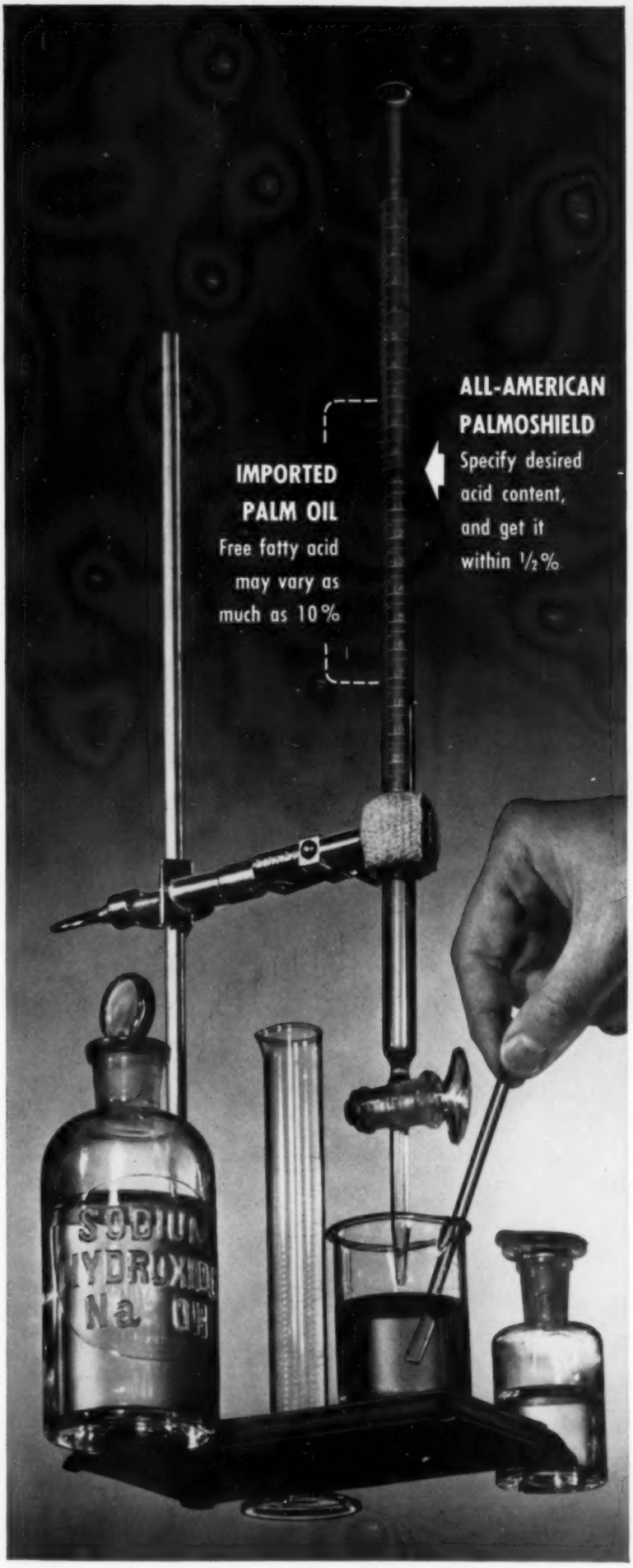
More Crane Valves Are Used Than Any Other Make!

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois

Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING



Now you can *specify free fatty acid content to ½%* ...and get it!

If you use imported palm oil in rolling operations, probably one of your biggest headaches is the wide spread from batch to batch in free fatty acid content, often as much as 10%.

With too high an acid content both your emulsion and your cleaner formulas may be thrown out of balance. And of course *any* wide variation from specifications can play hob with uniform performance and production control.

With Palmoshield, new all-American replacement for palm oil, you get the acid content you specify within ½% (± ½%).

Since Palmoshield is a scientific product, man-made from domestic materials, it is subject to exact chemical control. You can specify your preferred free fatty acid content on delivery, and you are assured this percentage will not change under normal storage.

Equally important in these uncertain times is the fact that Palmoshield is an all-American product made from freely available domestic materials. Users are not dependent on overseas shipment from foreign-controlled sources. A call to Ironsides in centrally located Columbus brings immediate shipment.

Palmoshield has been under test for three years in cold rolling steel production under standard operating conditions. Results show that the new lubricant duplicates the chemical characteristics of the imported product and that it is in certain ways superior.

Palmoshield is already in successful use in several leading rolling mills. It is available for immediate shipment in 55-gallon drums and in tank car lots. Competitively priced. For full details call or write The Ironsides Company, 270 West Mound Street, Columbus, Ohio.

SPECIAL LUBRICANTS *and* PRESERVATIVES

SHIELD PRODUCTS

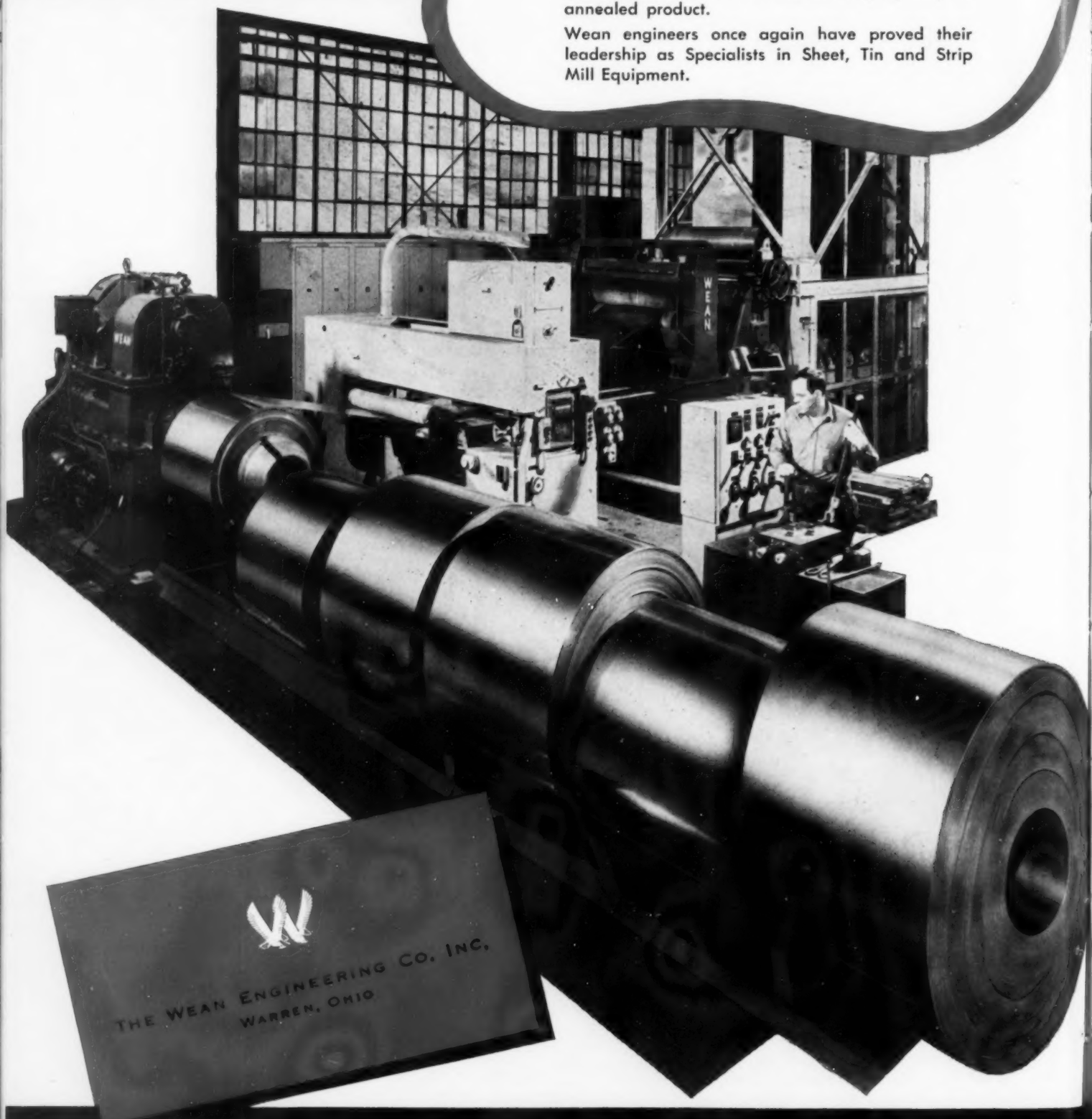
IRONSIDES
PALMOSHIELD

WEAN

TOWER TYPE *Annealing*

THE combined efforts of Wean-Drever engineers produced the First successful gas fired Furnace for the continuous annealing of Tin Plate. Wean-Drever Tower Type Annealing conserves valuable floor space — produces a uniform high quality of annealed product.

Wean engineers once again have proved their leadership as Specialists in Sheet, Tin and Strip Mill Equipment.



SPECIALISTS IN SHEET, TIN and STRIP MILL EQUIPMENT

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
ALBERT W. ERICKSON, JR., *Production Manager*

Board of Directors

PRESIDENT
I. N. TULL
Electrical Superintendent
Republic Steel Corp.
Cleveland, Ohio

FIRST VICE PRESIDENT, JOHN L. YOUNG, *Vice President—Chief Engineer,* United States Steel Co., Pittsburgh, Pa.

SECOND VICE PRESIDENT, E. L. ANDERSON, *Electrical Superintendent,* Bethlehem Steel Co., Johnstown, Pa.

TREASURER, JOHN H. VOHR, *General Superintendent,* Gary Works, United States Steel Co., Gary, Ind.

SECRETARY, W. H. COLLISON, *Assistant General Superintendent,* Blast Furnace Division, Great Lakes Steel Corp., Ecorse, Mich.

PAST PRESIDENTS: C. H. WILLIAMS, *Assistant Executive Vice President Engineering and Raw Material, Manufacturing Division,* United States Steel Co., Pittsburgh, Pa.

A. S. GLOSSBRENNER, *Vice President Operations,* Youngstown Sheet and Tube Co., Youngstown, Ohio.

HONORARY DIRECTORS: JAMES FARRINGTON, *Special Assistant to Chief Plant Engineer,* Wheeling Steel Corp., Steubenville, Ohio.

CHARLES L. McGRANAHAN, *Technical Assistant to Works Manager,* SOLLAC, Seremange (Moselle), France.

L. F. COFFIN, *Assistant General Manager,* Bethlehem Steel Co., Sparrows Point, Md.

DIRECTOR-AT-LARGE: JAMES D. O'ROARK, *Assistant to Manager of Service—Maintenance,* Weirton Steel Co., Weirton, W. Va.

DIRECTORS: B. C. BLAKE, *Vice President and General Manager,* Connors Steel Co., Birmingham, Ala.

W. G. SMITH, *Assistant General Manger,* Bethlehem Steel Co., Lackawanna, N. Y.

R. W. HOLMAN, *Division Superintendent of Maintenance,* Sheet & Tin Mills, United States Steel Co., Gary, Ind.

LEONARD LARSON, *Chief Engineer,* Republic Steel Corp., Cleveland, Ohio.

WILLIAM J. REILLY, *General Production Manager,* Ford Motor Co., Dearborn, Mich.

R. W. COUCH, *Superintendent of Saucon Mills and Shipping Yards, Saucon Division,* Bethlehem Steel Co., Bethlehem, Pa.

A. G. ERICSON, *Chief Engineer, Homestead Works,* United States Steel Co., Munhall, Pa.

R. W. GRAHAM, *Superintendent, Electrical Department,* Bethlehem Steel Co., Lackawanna, N. Y.

E. A. HAWK, *Fuel Engineer,* Tennessee Coal, Iron & Railroad Co., Ensley, Ala.

A. K. BLOUGH, *Superintendent, No. 2 and 3 Melt Shops,* Republic Steel Corp., Canton, Ohio.

J. N. IMEL, *Superintendent, Continuous Strip and Sheet Department,* Jones and Laughlin Steel Corp., Pittsburgh, Pa.

JAMES J. HEALY, *Project Engineer,* Armco Steel Corp., Middletown, Ohio.

D. N. EVANS, *Assistant Master Mechanic,* Inland Steel Co., East Chicago, Ind.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pa.

Iron AND Steel ENGINEER

MARCH, 1952 VOLUME XXIX NUMBER III

In This Issue

High Temperature—High Speed Heating for Steel Rounds—By A. F. Kritscher, Development Engineer, National Tube Division, United States Steel Co., Pittsburgh, Pa. 55

Effect of CaO:MgO Ratio in the Neutralization of Pickle Liquor—By Francis J. Clauss, National Advisory Committee Aeronautics, Cleveland, Ohio and Lloyd E. Brownell, Professor Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor, Mich. 63

Program—AISE Annual Spring Conference 71

Has Industrial Tractor Design Kept Pace with Steel Mill Operating Requirements?—By Carleton Lord, Materials Handling Engineer, United States Steel Co., Pittsburgh, Pa. 75

Emergency Drive Arrangements for Blooming Mill Auxiliaries—By F. C. Fennell, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., E. Pittsburgh, Pa. 82

Production of Steel by the Oxygen-Impingement Process—By Th. E. Suess, United Austrian Iron and Steel, Linz/Donau, Austria 91

Modern Hydraulic Applications—By John R. Carlson, Berry Div., Oliver Iron and Steel Corp., Pittsburgh, Pa. 94

Operating and Economic Aspects of High Speed Tandem Cold Reduction Mills—By F. K. Schefe, Flat Products Engineer, United States Steel Co., Pittsburgh, Pa. 103

An Introduction to Clad Metals—By Walter L. Keene, Director of Research, Superior Steel Corp., Carnegie, Pa. 109

Current AISE District Section Meetings 120

Specifications for Design of Hot Metal Ladles AISE Standards No. 9 ..... Following Page 119

Weldments Find Increased Use in Gear Drives—By C. J. Schorsch, Gear Proposal Engineer, United Engineering and Foundry Co., Pittsburgh, Pa. and Robert Hirsch, Welding Engineer, The Lincoln Electric Co., Cleveland, Ohio 122

Silicone Possibilities Demonstrated in Display 128

Date-Line Diary 135

Industry News 143

Personnel News 161

Applications for AISE Membership 179

Equipment News 183

Index to Advertisers 201

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

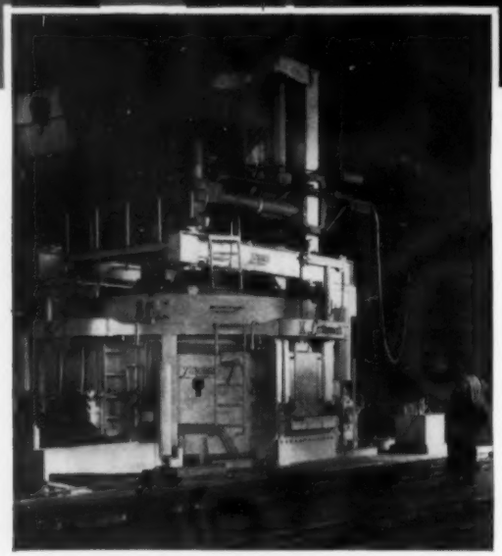
Copyright, 1952 The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1970285 LICENCE NO. 120.

Strong, sound irons for special castings are produced in this Lectromelt Furnace at Ferro Machine & Foundry Company, Cleveland.



Lectromelt Furnaces grow BIG, too.

Nicknamed "The Drugstore" because it fills prescriptions so accurately...

"With our electric-furnace duplexing process, we are able to produce special irons for a great variety of castings requiring heat and wear resistance and ability to withstand extreme pressure... and do it economically."

In the duplexing process at Ferro Machine & Foundry Company, molten iron from the cupola is poured into the Lectromelt Furnace. There, elements are added or removed to give the exact composition specified and the charge is superheated electrically to achieve a fine-grain structure. Thus, special irons are produced as regular routine.

Lectromelt Furnaces range in capacities from 24 pounds to 150 tons, meeting every development and production requirement. They're on melting, refining, smelting and reduction work. For Bulletin No. 7, telling you more about them, write Pittsburgh Lectromelt Furnace Corporation, 310 32nd St., Pittsburgh 30, Pa.

Manufactured in... CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2... ENGLAND: Birlec, Ltd., Birmingham... SWEDEN: Birlec, Elektrougnar A/B, Stockholm... AUSTRALIA: Birlec, Ltd., Sydney... FRANCE: Stein et Roubaix, Paris... BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege... SPAIN: General Electrica Espanola, Bilbao... ITALY: Forni Stein, Genoa.

WHEN YOU MELT... MOORE RAPID *Lectromelt*

HIGH TEMPERATURE --- HIGH SPEED HEATING

For Steel Rounds

By A. F. KRITSCHER
Development Engineer
National Tube Division
United States Steel Co.
Pittsburgh, Pa.

A. F. KRITSCHER

. . . . application of principles of high speed heating to new types of heating units has resulted in economy in heating and better quality of product . . . . in addition development work has brought out a number of new heating principles . . . .

▲ THE principle of high temperature-high speed heating for large solid steel products has been discussed throughout the steel industry for the past five years, but the subject never matured beyond the stage of discussion, mainly because most of the known rules and concepts of heating steel must be disregarded and a new set of heating principles accepted.

Because the heating of rounds for making seamless pipe and tubing is probably the most critical application of heat in the steel industry, and because there is always concentrated effort to improve the existing product, the National Tube Co. initiated a program in 1948 to thoroughly investigate the possible advantages of high temperature-high speed heating.

Since the heated tube round is pierced in a rotary piercing mill, it can well be seen that the concentricity of the final product is greatly influenced by the initial hole pierced longitudinally in the billet. If this round is unevenly heated, the temperature differential can produce an uneven flow of metal over the piercing point, and the resulting hole in the tube blank may very readily be eccentric with relation to the outside diameter of the tube. In the National Tube Co., the hand roll-down furnaces with their high manpower requirements were developed to a stage where it would not be economical to redesign and improve this type of unit, so several of the more recently developed rotary furnaces were incorporated into the producing facilities. These units have the advantage of reduced manpower requirements, but involve increased machinery and refractory maintenance. Improved heating results are obtained from this type of furnace, mainly because of its large size which permits the steel to be heated slowly and to soak at a temperature which produces an evenly heated billet, even though the billet is not rotated and lies stationary on a hearth. The fuel economy is little improved over the roll-down furnace, and although these units are comparatively airtight, a scale loss still exists, chiefly because the hot steel is at high temperature for a long period of time. Since it is well known that time at temperature determines the amount of scale and character of the scale formed on steel, it was felt that high temperature-high speed heating would be advantageous in the control of scale loss.

The basic principle of high temperature-high speed heating involves exposing the cold steel to a very high temperature radiant surface. An experimental unit was designed to convey the cold steel between two high temperature radiant panels to heat small tube rounds quickly and evenly for piercing.

The experimental panel-type unit was designed and installed at the Ellwood works in such a manner that the heated billets could be directly introduced into a piercing mill and compared with heated steel of the same size from a conventional roll-down furnace.

The tests were carried to a stage where it was proven that 2½-in. rounds could be heated to a piercing temperature of 2200 F in ten minutes or at a rate of four minutes per in. of diam. This means an average heat rate of 52,500 Btu per sq ft of steel surface per hour. The resulting tubes were very satisfactory in quality.

It is interesting to note the difference in the heating

rate per in. diam in the three types of heating equipment currently used in the National Tube Co. for heating rounds. The hand-rolled down furnaces require 20 minutes per in. of diam, the rotary furnace 15 minutes, and the high temperature-high speed furnace 4 minutes.

From the data accumulated by these tests, it was possible to determine the basic principles of a unit to be installed with a new seamless mill now operating at the Gary works of the National Tube Co. The high temperature-high speed unit installed in conjunction with a modern high speed mill had to have the flexibility for making a variety of products. Production requirements necessitated heating a maximum of 40 tons per hr and a minimum of eight tons per hr in a program which averaged approximately 19 tons per hr. The tests made on the original experimental unit brought out that the best way to apply the principle of high temperature-high speed heating is to expose the cold steel to the high

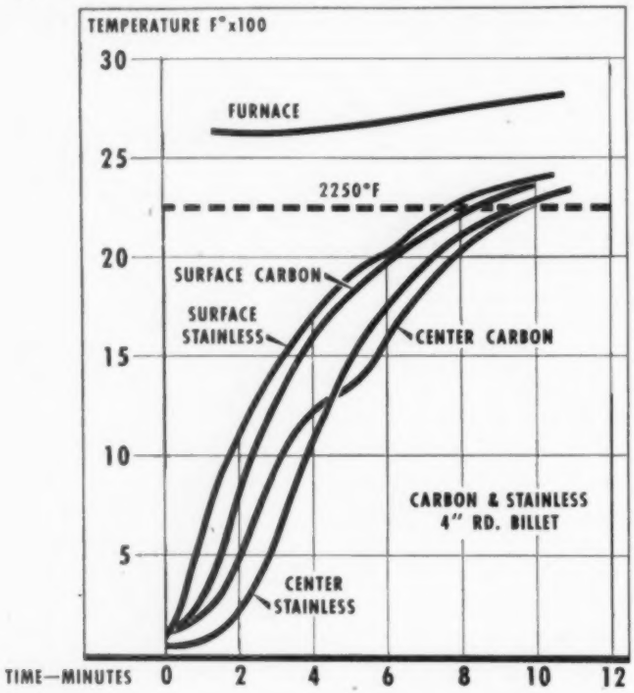


Figure 1 — Curves give heating rate on experimental barrel furnace with a heat input of 2,840,000 Btu per hr.

temperature radiant surfaces from four sides. As one realizes, this is a rather difficult application if the material must roll or lie on a hearth. Since the tube rounds are received at Gary works in lengths of 30–40 ft, it was felt that the ideal heating application could be accomplished if these bars were conveyed through the center of a barrel type furnace which maintained a very hot internal surface. The barrels could be placed end to end with driven conveyor rolls between each barrel and, as the heated bars emerge from the last barrel, they could be cut to desired lengths and introduced directly into the piercing mill.

This basic concept of handling and exposing the material most advantageously for high speed heating, was used in the engineering, design, and construction of such a high temperature-high speed heating unit.

To determine the design for finalizing this application of high-speed heating, four barrels were experimentally constructed and equipped with high-temperature gas burners. Several billets were then heated in this setup with surface and center thermocouples recording the temperatures of different diameter billets at various speeds. The heating rate tests in the experimental barrel furnace revealed the ability to heat carbon and stainless steel at high rates. With 2700 F temperature heads in the barrel, it is apparent that greater heating rates are attainable than heretofore thought possible (Figure 1). Upon proving that the desired heat rates and temperatures were practical, the design of charging and discharging facilities for the billets was initiated.

Concurrently, an intense program was launched to develop a type of radiant burner which would not only burn gaseous fuels, but also stand-by liquid fuel. It might be pertinent to point out that the steel industry must spend millions of dollars to protect itself with stand-by facilities in order to assure continuous operations. Not only investment costs, but operating costs could be saved, if an assured supply of gas could be obtained from utilities or gas systems within the plants.

High heat release gaseous fuel burners had been operating and proven but, due to the unreliability of the supply of gaseous fuel, a completely new type of burner had to be developed which would also burn fuel oil.

Since oil is usually burned in refractory tunnel blocks, the confronting problem was how to burn both gas and oil in a common radiant cup burner block. After many trials and disappointments, a new principle was evolved which maintains the radiant cup and utilizes a metallic closed end tube having burner port holes arranged radially near the closed end. The gas and air would not intimately mix until they passed through the radial holes. The many small flames pass along the surface of the refractory cup, producing a high temperature radiant surface.

To burn cold fuel oil through a multitude of small ports uniformly without coking was in the end successfully accomplished by the combination of a special and novel oil vaporizing chamber with a high pressure air atomizer tip, which sprayed an oil mist into the chamber. Secondary air, introduced to mix intimately with the oil mist, provides a combustible mixture leaving the multiple ports of the burner tube.

Since the end of the metallic burner tube protrudes through the burner block, the tip absorbs heat by radiation from the refractory furnace walls, and is of such design and contour that it acts as a vaporization catalyst to the oil mist.

A combination burner was designed which would adapt oil to high speed gas burning and which used a new type of high pressure air-oil atomizing tip and oil control system.

The aim and object of this combination burner development was to eliminate a radiant gas firing system with carburetor, high-pressure blower, firechecks, explosion prevention devices, and a multiplicity of small burners.

This burner is essentially a nozzle-mixing burner capable, with its component refractory cup, of heat releases up to 450,000 Btu per cu ft of furnace volume per hr, which is accomplished by using gas and air under comparatively low pressures, with conventional metered gas-air ratio controls.

As invariably happens, when production started, it was necessary to operate on the stand-by fuel oil for

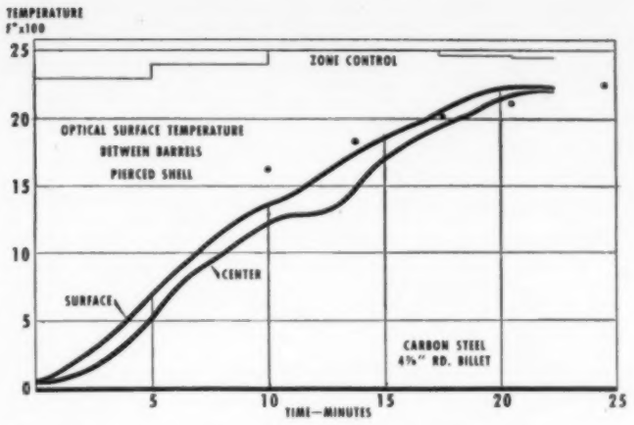


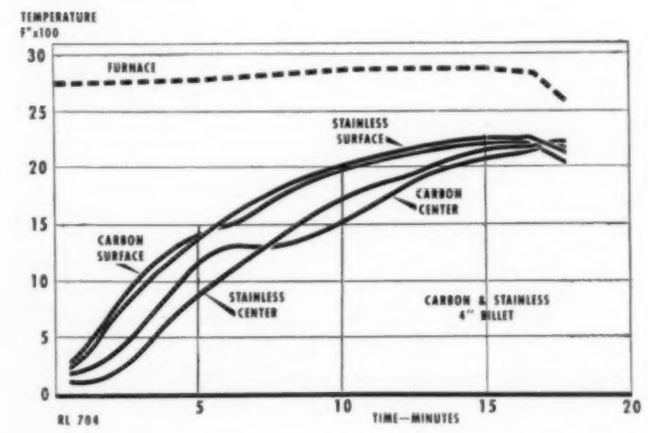
Figure 2 — Curves show heating rate obtained in production on No. 3 seamless mill at Gary works in November 1950.

the first few months even though this combination burner was not completely developed nor extensively field tested. Further work in the field was necessary by the two burner manufacturers to develop the final burner arrangement. The success of this combustion system development has enabled the furnace line at Gary to operate continuously for extended periods on either oil or gas with equal results, and on several occasions, part of the line was using gas while another section burned oil.

The development was further complicated by the necessity of using coke oven gas. A burner of this type burning natural gas presents little difficulty. The rapid flame propagation inherent in coke oven gas, with its high hydrogen content, presented an entirely different problem and was the cause of burner failures in the initial startup. I wonder how many combustion engineers truly appreciate the important differences of coke oven gases made in different localities, and with different hydrogen and sulphur contents.

Burning characteristics, such as flame propagation, explosion speed, sulphur attack, etc., influence not only burner performance, but burner design, burner life, and heat release. For instance, a burner tested on coke oven gas in a Pittsburgh plant indicated satisfactory performance, but failed quickly when applied in the Gary district.

Figure 3 — Comparative heating rates of stainless versus carbon steels are given for billet heating furnace at Gary works.



As previously mentioned, the design and construction of the heating furnaces progressed as dimensional and refractory tests were completed.

It was found that the heating efficiency of the combustion chambers could be increased by passing two billets side by side through the barrels, but this presented a problem in cutting the heated bars since both bars would be emerging from the last barrel at the same time. Not only would it be undesirable to cut two billets simultaneously and then pierce each individually, but the front end of the billet would be colder than the trailing end due to cooling in air as the steel emerges slowly from the last barrel.

An ingenious scheme was devised by which the billets could move through the barrels at a predetermined heating rate and yet be removed from the last barrel quickly (without uneven cooling), be sawed and then transferred immediately to the piercing mill.

Required production speeds, furnace length, and billet diameters were coordinated and adjusted in such a manner as to enable the round bars to move through the heating chambers at a set rate so that when enough heating time has elapsed to reach rolling temperature, the bars are gripped by pinch rolls.

These split pinch rolls, by means of an electrical impulse, rapidly eject a single heated bar from the furnace to a measuring discharge table Upon contact with the measuring switch, the pinch rolls stop, hydraulic clamps hold the billet firmly, and a hot saw severs the bar into accurately measured lengths.

After severing, the discharge table holds the billet with a clamp while making a movement to clear the saw, and the end of the hot bar exposed while cutting is retracted into the last furnace barrel to prevent cooling of the billet. Thus, the ends of the billets are always hot. The severed billet proceeds to the piercing mill where it is automatically centered and then pierced.

The unproven functions of discharging, measuring and cutting these billets automatically were initially considered most questionable operations and possible trouble spots. Of course, as originally installed — as in most new developments of such scope — the electrical sequence control was designed and engineered for every conceivable condition. This complicated the original installation and was largely responsible for minor delays during the initial starting-up period. Through combined efforts of operators and engineers, the sequence control system was refined to actual requirements without affecting the overall ejecting cycle. The cycles involved work very well and the expected grief never materialized. It is interesting to note that the life of a saw blade (between sharpenings) when cutting hot steel at forging temperatures (2200-2250 F) is increased by approximately tenfold as compared to saw life when cutting hot steel as finished from a rolling mill.

The complete discharge cycle is in electrical sequence. The rate at which the billets are discharged is set by the piercing mill operator. If one heating line is operating, billets are ejected and retracted alternately. When two lines are working, billets are discharged in rotation. The number of lines in operation is determined by the tonnage required by the mill. The discharge cycle is sufficiently fast to deliver the number of pieces required, providing the tonnage does not exceed the heating capacity of the line. The mill operator also has at his

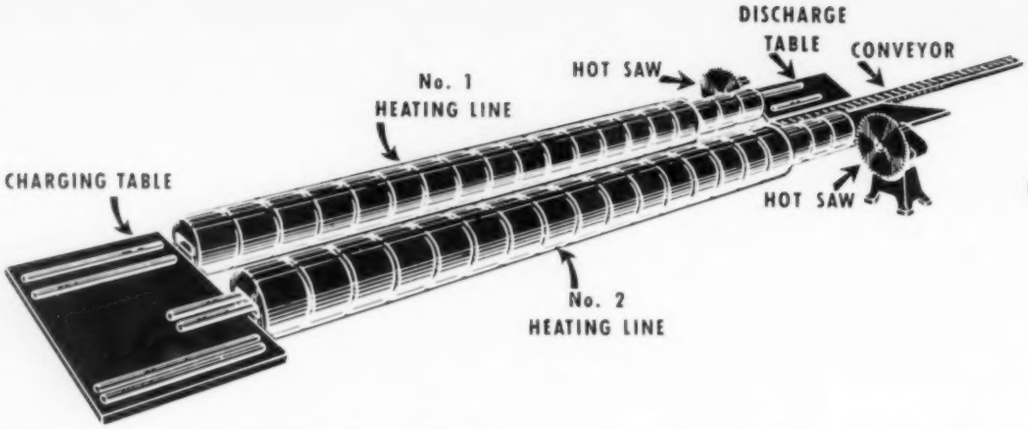


Figure 4 — Billet heating line at Gary Works.

control an oscillating button which stops delivery of billets from the furnace.

Whenever a mill delay occurs, the heating lines are directed to hold their position or oscillate. This means that the continuous flow of material is stopped and must be held in such a condition as to immediately provide heated steel when the mill requires it.

During short time delays, the entire conveyor roll system goes into a cycle during which the conveyor rolls reverse their rotation every few seconds. Since these rolls are installed at an angle of 8 degrees to the perpendicular axis of billet movement, the billet is caused to rotate during oscillation as well as during heating.

If a scheduled delay occurs, such as a mill change, the heating line is permitted to go empty, as only twenty minutes are required from cold charging to discharging hot steel.

If a mill breakdown occurs, the steel can be withdrawn from the furnaces by reversing the rolls and unloading from the charging table.

When oscillation occurs, the fuel is quickly reduced to a predetermined minimum setting which prevents overheating of the steel and maintains a temperature gradient throughout the furnace line. The fast control of temperature is made possible by the type of burners employed and the construction of the barrels. As soon as the gas is cut, the temperature of the radiant cups drops quickly. This always occurs where a high heating principle is employed because the ratio of fuel input to wall area or furnace volume is so great; however, it requires a wide turndown burner because the fuel input must be reduced to a low minimum. Conversely, appreciable time and expense are saved in starting the furnace.

One or two-turn operations, or week-end shutdowns, allow the furnace to be emptied and shut off, saving both fuel and furnace attendant. The heater, reporting for work three hours before production is scheduled to start, can have steel ready after a week-end shutdown.

The temperature control of the heating unit is presently functioning from a radiation unit sighted on a closed-end refractory tube. A radiation unit per zone is used. The closed-end tube, inserted through the wall of the barrel as close as practical to the steel, seems to provide a measuring temperature which is relative to actual conditions within the barrel. Different methods of obtaining a control temperature have been tried, such as direct reading radiation instruments with open-end sighting tubes located in different positions, but the variation of conditions during an individual heating cycle leads to fluctuating operation of the control instruments. For instance, the firing rate within the barrels causes a variation in characteristics of the flue gas stinger issuing from the furnace, especially as to volume, density and radiation. Even if the sighting tube is very close to the steel surface, the exhaust gas stinger has a decided effect. Then, too, the effect of a thin layer of scale affects the emissivity from the billet, especially between the multiple barrels. If a long period of oscillation occurs, the hot steel surfaces moving from furnace to furnace will become scaled, even though the spaces between the barrels are enclosed by refractory shrouds. Although there is little change in billet temperature, the formation of this scale and the difference in reradiation characteristics of the shrouds and barrels cause direct reading instruments to call for more fuel. Overshooting of temperature and fuel flow fluctuation prompted the change from direct reading radiation units to units sighted on a closed-end refractory tube.

The present temperature control arrangement gives satisfactory unit operation but is not perfect. Additional improvement in more accurate temperature measurement is desirable and would improve the ease with which the unit could be operated.

A high-speed strip chart recording potentiometer records the temperature of the billet as it emerges from the piercing mill. Furnace temperatures and line speeds are controlled to obtain the desired piercing temperature.

Experience indicates that maximum top temperature settings for the group of barrels comprising zones seem to be the best means of control, especially in obtaining the most desirable heating rate and the best refractory maintenance; also, a minimum controlled firing rate for holding or oscillating the billets by a predetermined setting of the instruments, depending on the size of steel heated.

The actual production Heat Rate Chart of a 4⅞-in. billet shows the zone control settings under operating conditions. The surface and center temperature are recorded by thermocouples with a high speed multipoint recorder. The optical readings are shown by circles (Figure 2).

One of the features of small individual heating units is the ability to maintain a high temperature head in the first zones where the entering steel can absorb the heat rapidly and yet not disturb the control of the rest of the furnace. It should be pointed out that excessive temperature heads in the entering zones may have a

decided effect on the billet scale condition if the production rate is considerably below the capacity to heat the rounds, since the billets would be at desired rolling temperature long before they would be rolled on the mill.

Progressive improvements have been made to furnace construction and refractory assembly due, chiefly, to the small amount of scale which does form. When the cold billets enter the hot barrels, any residual mill scale spalls from the steel and is carried out of the barrels by flue gases or is collected and removed. This is a dry type of scale without adhesive characteristics. As the billets progress from zone to zone and become hot, a thin new tight scale is formed which adheres to the billet. A definite problem arose under oscillating conditions in the discharge part of the furnace. Time at temperature permits the scale to become thick enough to be loosened by the conveying rolls and it drops into the hot discharge barrels. Although the amount of scale is relatively small, there is an accumulation over a period of time. This causes refractory maintenance because of fusion. The removal of this scale from hot barrels was a problem and many different methods of removal were attempted.

Temperature shocks due to rapid heating and the rapid temperature changes from the operating cycle to the oscillation or idling cycle further aggravate the refractory problem. The solution to the problem is to maintain a definite high temperature limit in the hot barrels and construct the refractory lining of such a shape and analysis that the scale accumulated does not fuse within the chambers. Our operators and maintenance people have really displayed infinite patience as well as outstanding ingenuity in solving some of these problems.

It is notable that while the above troubles were encountered, the operating time lost was held to a minimum. With the multi-barrel unit, it is possible to remove a chamber quickly and to replace it without affecting the operation of the other units in the line.

Further improvements developed under operating conditions were the reduction of water-cooling on barrels and rolls; the placing of refractory shrouds between the barrels which reduced the fuel consumption and also the scaling. Ventilation of flue gases from the barrels themselves was found more desirable than ventilating the gases between the barrels because of the stack effect of the hot gases which drew enough air into them to affect the scale, even though there was no appreciable heat loss from the steel.

The progress made to date on this type of heating unit reveals that the principle of heating steel by this method has many advantages and several revelations are hereby contributed to the principles of heating steel:

1. Accepted rules of heating steel to forging temperature, such as five minutes per ⅛-in. of diam, can only be applied to a specific type of furnace.
2. Heating formulas now used throughout the industry should contain a factor involving the number of sides exposed to heat radiating surfaces. For instance, it is common practice to heat steel billets from one side at a rate of 100 lb per sq ft of steel hearth area per hr (Trinks). This means 35,000 Btu heat transfer per sq ft of steel surface per hr. This is not a high heat transfer rate; however, if we heat the billet from four sides and maintain 35,000 Btu per sq ft per hr heat transfer rates, we can reduce the heating time to one-fourth of the previous rate. This is high speed heating.

   This concept seems relatively simple but full appreciation of other factors must be realized. Exposing more material surface increases the ability of a given piece to receive heat; thus, large quantities of fuel must be burned in small furnace volumes to maintain furnace temperatures.

   One must realize that to get maximum speed with a safe furnace temperature, the input zone temperature must be maintained much higher than normally is considered necessary and the heat input to each zone in a continuous heat furnace must be carefully calculated. Low entrance zone temperatures can easily double the heating time.
3. Different grades of steel can all be heated quickly if they are completely exposed. Sharp cornered squares of SAE-52100 will not crack when heated quickly to high temperatures if completely ex-

Figure 5 — Capacity of double line high temperature-high speed heating unit at the Gary works of National Tube Co. is 40 tons per hr.

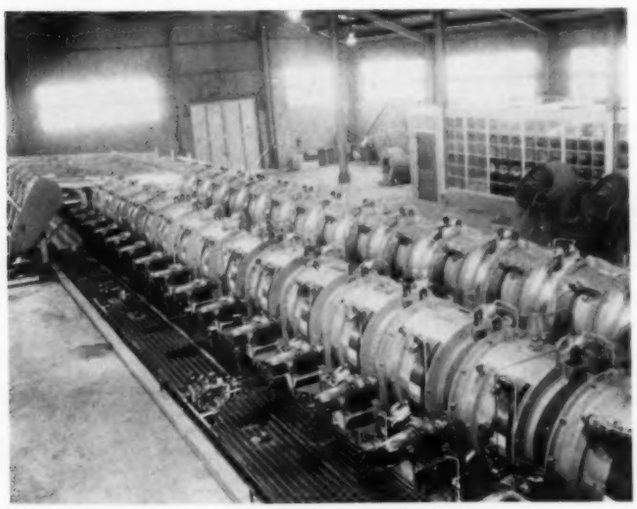
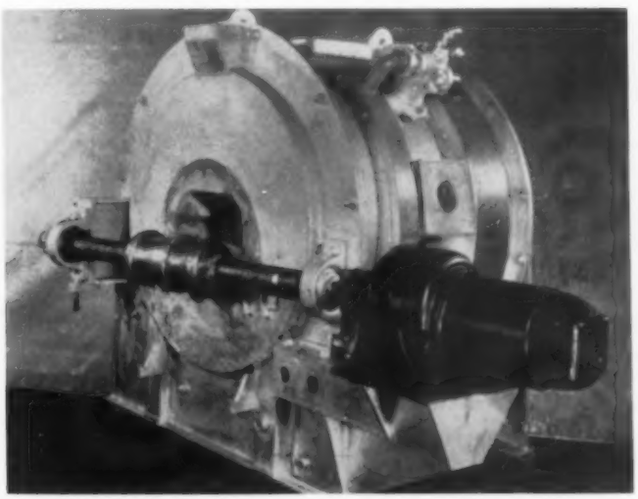


Figure 6 — Individual heating unit shows integral conveyor roll, motor, and drive.



posed, such as by conveying them through the center of a high temperature barrel.

4. Stainless and heat resisting steels will heat more quickly than carbon steels under identical conditions. Figure 3 shows a test run made by placing carbon and stainless steel side by side and passing them through the barrels. This is not a matter of emissivity since both scaled and polished pieces were tested.
5. The speed of heating has a definite effect on the power required to deform metal. Comparative tests indicate 20–25 per cent less power is required to pierce fast heated rounds than slow heated or soaked rounds.
6. The burning of gas and oil in a common fuel burner is possible, having identical flame conditions without pregasification of oil.
7. Heat releases as high as 435,000 Btu per cu ft of furnace volume are possible in a small chambered furnace — using cold fuel oil.

The aforementioned installation as applied to heating of tube rounds has the following advantages:

1. A uniformly heated steel round superior to any other known installation.
2. Less scale loss per heated ton than with conventional furnaces.
3. Reduced material handling cost, since long bars are taken from outside storage directly to the heating line, eliminating the transferring, measuring, cutting, stocking, and recharging necessary with conventional furnaces.
4. Reduced billet cutting costs by hot sawing.
5. No long period shutdowns for repairs.
6. Greater flexibility with two heating lines for a specialty mill having fluctuating production requirements.
7. Ability to furnish minimum requirements for heating by selective use of the number of barrels in operation. Reduced area of heat losses in proportion to tonnage heated.
8. Maintain constant Btu requirements per ton, regardless of tonnage heated.
9. Ability to shut down and light up furnaces quickly, saving fuel and labor during week-end shutdowns.
10. Monthly average fuel consumptions are not greater than on conventional furnaces of the same capacity.
11. Reduced power for metal displacement.
12. Reduced operating personnel, charger and heater, without high maintenance of charging and discharging machine.

The desirable improvements to be made or perfected are:

1. Improved refractory life — progress is being made toward this end with gratifying results.
2. Longer life of burner tips — a definite program of investigation and testing is being followed.
3. Recuperation — with barrel vents the unit lends itself to be readily adapted to this principle.

In conclusion, the National Tube Co. is proud of the pipe and tubing produced by this new mill at Gary, and, of course, the furnace line is a definite factor in the production of this quality product.

DISCUSSION

PRESENTED BY

F. O. HESS, President, Selas Corp. of America, Philadelphia, Pa.

J. E. HOVIS, General Manager, Bloom Engineering Co., Pittsburgh, Pa.

A. F. KRITSCHER, Development Engineer, National Tube Division, United States Steel Co., Pittsburgh, Pa.

A. B. CAPRON, Superintendent, Tubular Products Division, Babcock & Wilcox Co., Beaver Falls, Pa.

H. R. McLAREN, Assistant General Superintendent, The Timken Roller Bearing Co., Canton, Ohio.

Frederic O. Hess: We are very fortunate indeed that men of courage and vision are occasionally permitted by their organizations to proceed with new exploratory installations in an effort to make progress— to improve production methods or quality, or both — which, after all, has been the foundation of our technical progress and which, today more than ever, is necessary to keep ahead and stay ahead of higher labor and material costs and international competition.

That this installation involved major risks must be clear to anyone having listened to Mr. Kritscher's paper, or studying the facts presented in comparison to the previous practice. The method of handling was new and never tried before. The method of heating was new and never attempted on this scale and with solids.

The method of combustion was new — in fact all authorities maintained it could not be done — to burn oil or coke oven gas in radiant burners at high combustion rates. To make matters easier for the operator, but considerably worse for the design and development engineers, we set out to do so with a single set of burners and even without a change of parts, by merely requiring shutting off valves to switch from oil to gas.

The method of automatically sawing hot billets to piercing length was new, and so were many other details of construction.

It was not new, however, that we experienced troubles, even though we did not carelessly invite them. Yes, we did have trouble, with scale during the on-and-off tryout of a mill designed for continuous production, and now working because of the splendid spirit and hard work of all the people involved in the installation— particularly the engineering and maintenance crew of National Tube. We had trouble with burners too, and we admit these difficulties with apologies to the people who suffered because of them — but without apologies to the industry. Who ever made progress or attempted something new without work, hard work, and some unforseen problems?

At least two facts have been established on an indisputable production and performance basis:

1. Solids can be heated fast and do not require soaking to make them workable, even for as drastic an operation as piercing.

2. Fast heating makes the hot working easier, as shown by the power requirements in comparison to soaked billets. Power itself is, of course, a minor factor — the important effects should eventually be represented by longer life of wearing parts, such as piercer points, and a wider operating range.

No one in his right mind would maintain that this installation represents the final word in heating of solids for piercing — but a way has been shown. It has again been proven that heating methods deserve further development, and must include consideration of time factors to assure maximum benefits for the mill, the fabricator and quality of end product. Operating facts from other installations, such as continuous bright anneal of steel strip, short cycle normalizing of pipe, etc., point in the same direction.

In closing I repeat that we are fortunate indeed that especially the steel industry continues to foster some of these novel methods of operation, even though the accountant and the competitor often decry development expenses and trouble associated with pioneer efforts.

J. E. Hovis: Mr. Kritscher has covered many interesting concepts not common to the conventional heating furnace. One of these concepts stresses the importance of applying sufficient fuel to the charging end of a high-speed furnace. It is our experience that this factor is sometimes overlooked in such an application.

As you noticed in the curve previously shown by Mr. Kritscher, the rate of temperature rise in the initial part of the heating was considerably more than that in the final stages of the heating. The difference amounts to four to five times. Thus, if we are to attain the desired rate of heating, that is, some four minutes per in. of thickness, we must apply four to five times as much fuel per unit length in the charging end as in the discharge end of the furnace. Otherwise, the furnace temperature will drop until the heat balance is again attained between fuel input, furnace losses and heat to the steel; and as Mr. Kritscher stated, the heating time will be materially increased.

Mr. Kritscher also mentioned certain difficulties in the use of an open-end tube for temperature measure and control. If we look at the waste gases issuing from one of these furnaces, we observe a marked variation in appearance. Various conditions in the furnace are responsible for this variation. However, if we look through the stinger directly into the furnace, this variation in appearance is not noticed.

Thus, I wonder if it would not be feasible to insert an open-end tube through the wall of the furnace to a point relatively close to the steel. This would be of particular importance in the case of a re-heat line where the entering steel may vary in temperature.

I would like to ask Mr. Kritscher if any steps have been taken in this direction.

A. F. Kritscher: Yes, that has been tried, and due to the rotation of the billets going through the furnace and the permissible tolerances we allow for billets being bowed, we cannot get the open-end tube close enough to the billet to eliminate the effect of the change in density of flue gases during varying conditions.

A. B. Capron: The seamless tube industry has been interested in this furnace because of its entirely different approach to the heating problem. Many companies, our own included, have applied this principle generally to the re-heating of tubes ahead of sizing or sinking operations, using gas only, but this application is new.

Our company and many others are in what you might term the department-store type of business, where the orders are small and the changes in length, wall thickness and diameter are frequent, and we see some disadvantage to this furnace for our own business.

There are several questions along that line I would like to ask. In our production scheduling of a mill, we are often forced to cut not just one but two, three or even four different orders out of a single bar to economically utilize the entire length of the bar. That is on cut-length orders. I wonder what is done on this mill. Are the bars cut to a pre-determined length before insertion in the furnace, or is there a certain amount of waste from each bar as the billets are cut out?

The normal figures used in the past on the rolldown and rotary-hearth furnaces, in regard to scale loss, have been thought of as two and one-half to three per cent on a hand-operated rolldown furnace, or one and one-half to two per cent on a rotary, and I wonder which of these the author used as a base when he said that his furnace would show one per cent less loss than the normal furnace.

The third point I questioned was in the use of fuel oil. Do you mean the lighter oils such as No. 1 or 2 grades, or the Bunker "C" No. 6 type?

A. F. Kritscher: There are two ways to handle the problem of cut length orders. If the steel is requisitioned for a particular order on your books, the long length bars are received in desirable multiples, in which case there is no further handling in the mill. If the long bars are taken from stock, it is then necessary to pre-cut the bar on the charging table into a length which will satisfy the number of pieces required. The shortest bar length which can be charged is 9 ft-6 in., but this can be cut into three pieces, 3 ft-2 in. by the hot saw.

The scale loss on the new continuous unit is definitely less than either the rolldown furnace or the rotary furnace. It is recognized that scale loss is greater with specialty products or interrupted operations than with continuous operations. The fact still holds that the amount of scale produced depends on the time the steel is at a high temperature, and with this type of heating, the exposure time is always short.

As far as oil goes, we feel proud of the ability to burn No. 3 grade fuel oil through a high temperature radiant cup burner. Bunker No. 6 oil must be heated, and oil lines insulated together with steam tracer lines, which would have further complicated the development. It is believed that Bunker No. 6 can be and probably will be burned in this type of fuel burner in the very near future.

H. R. McLaren: This paper is the presentation of a very interesting installation and one which has been watched with great interest by the steel industry. There have been a lot of problems to solve, many of which have been solved to date by the skill of the operators and many of which I presume are still to be solved.

The first point of interest to me is what Btu per ton is now being obtained from this furnace? For the record, at The Timken Roller Bearing Co., we have one rolldown furnace and two rotary furnaces. The rolldown

furnace is operated at 2,500,000 Btu per ton and the rotary furnace at 2,800,000 and 3,100,000 Btu per ton.

The second point I would like to discuss is how the problem of high delay time on sensitive steels of various heating temperatures is handled. This is always a problem in the operation of mechanical furnaces. In the case of the rotary furnace, we take care of the delays by anticipating them and leaving empty spots in the furnace. This permits continuous rotation of the furnace at all times and thus the steel does not lie in the hot zone. In the case of short orders of specific heating cycles, time and temperatures, we have not solved this problem in the rotary furnace. Consequently, we take the delay necessary to leave an empty zone ahead of and behind the specific order.

When running short special orders through the continuous furnace, how can you be sure of leveling off correctly in the last zone to give the correct temperature to the piercing mill? I am specifically referring to such types as 52100, 2512, 2520, and columbium-bearing 18-8, etc.

The last point I would like to have cleared up is regarding the maintenance and refractory cost on the continuous furnace. I notice at the start of the paper that the rotary furnace at the National Tube Co. has a higher maintenance and refractory cost than the rolldown. This is not the case at The Timken Roller Bearing Co. where the maintenance and refractory maintenance on the rotary furnace is one-half of the cost on the rolldown furnace.

A. F. Kritscher: First, in relation to the Btu per ton, an average figure was stated in the paper and is approximately the same for a rotary furnace under similar operating conditions and schedules on the mill. Since we do have a fuel savings by shutting down the furnace over week ends, we must be using more fuel when operating, if the monthly average is the same as the aforementioned unit. However, I wish to point out that this high speed high-temperature heating line has been installed with a new rolling mill, and in starting a new mill there are always intermittent and interrupted operations.

Therefore, the existing performance records of the furnace line are constantly being improved as operating skills and techniques are perfected. It is probable that in a very short time — it might even be since this paper was written — the monthly Btu per ton figure will be less in the high speed line than in an equivalent rotary furnace.

Relative to the problem of high delay time on sensitive steels of various heating temperatures, as discussed by Mr. McLaren, I assume that the delays are usually due to mill changes necessary for orders of a comparatively few pieces. Because of the high heat storage content of the refractory mass in a large rotary furnace, a space must be left in the furnace and the zone temperature lowered, so that the steel does not heat faster than desired. As stated, the delay must be anticipated by perhaps two hours. The high temperature-high speed unit has definite advantages in this case, since there are two heating lines, and if a space is desirable, it can be left in one unit. Because of the low heat content of refractory in the barrel-type furnace, the temperatures can be varied quickly, so that the necessity of a space is questionable. However, if a space is desired, at no time would the space be anticipated by more than 20 minutes because of the fast heating.

It must be remembered that this new concept of heating disregards excessive soaking time and intermittent holding temperatures, so the danger of overheating or burning sensitive steels is minimized.

To clarify the statement of maintenance cost of a mechanical furnace, it is necessary to point out that a rotary hearth furnace in one plant will have an entirely different maintenance cost than in another plant, and the cost will vary directly with the number of pieces handled per minute. Since charging and discharging machines are engineered primarily to manipulate the heaviest billet to be handled, their maintenance varies according to the number of movements into and out of the furnace at the necessary speeds. Since the mass of the machine is many times the billet weight handled, it can be seen that the mechanical maintenance can vary tremendously for the same type and size of machine.

High speed-high temperature lines eliminate charging and discharging machine maintenance, since the steel is never picked up free of any conveyor rolls or skids.

The refractory cost, as I mentioned, is one of the present problems. Granted, there was a lot of trouble during the starting-up period with refractories, but the operators have made commendable progress by the use of different types of refractories, various shapes, and even molded linings. Their diligent attention to the problem is showing results. Eventually, there should not be any excessive refractory cost. This principle of heating is still in the refinement stage, and at present, we do not see any one particular problem which cannot be improved or solved.

There is a demand for copies of the following Yearly Proceedings:

1940 **1942**

1941 **1943**

1944

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

EFFECT OF CaO:MgO RATIO

in the Neutralization of Pickle Liquor

By FRANCIS J. CLAUSS
National Advisory Committee Aeronautics
Cleveland, Ohio

and

LLOYD E. BROWNELL
Professor of Chemical and Metallurgical Engineering
University of Michigan
Ann Arbor, Mich.

. . . . a CaO:MgO ratio of about 96:4 gives best rates of filtration for neutralized slurry . . . .

▲ NEUTRALIZATION of steel mill waste pickle liquor by lime results in the formation of a slurry which is difficult to filter or settle. Some improvement in filtration rates is possible by the use of lime of the proper composition. The primary purpose of this investigation has been to study the effect of the CaO:MgO ratio in the lime used on the filtering characteristics of the neutralized waste pickle liquor slurry.

CaO:MgO ratios from 100:0 to 60:40 parts by weight were studied as this range includes those compositions encountered in going from the high calcium limes to the dolomitic limes supplied commercially.

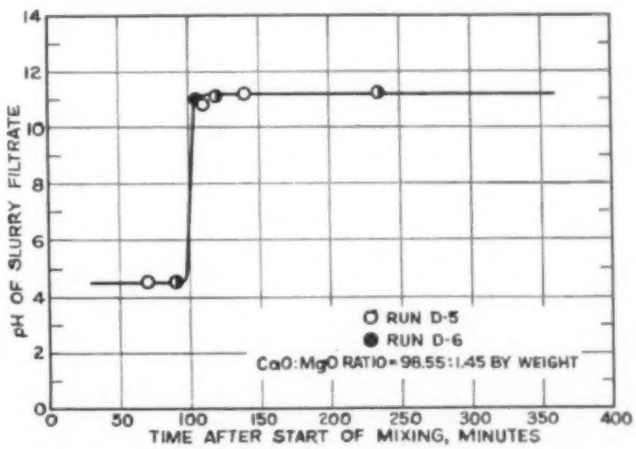
The relationships between the volume of filter cake and the filtration rates obtainable with the two variables lime composition, and operating pressure drop of filtration have been determined and are presented in graphical form. It is shown that there exists an optimum CaO:MgO ratio of approximately 96:4 parts by weight for obtaining maximum rates of filtration in the practical range of operating pressures.

In addition, the volume of filter cake produced from a given volume of slurry is decreased, and the time required for the neutralization reaction to be completed is appreciably increased as the CaO:MgO ratio is decreased.

Waste pickle liquor is essentially an aqueous solution of ferrous sulphate and sulphuric acid. The exact analysis varies widely, but 10 per cent H_2SO_4 — 10 per cent $FeSO_4$ — 80 per cent H_2O by weight is a representative analysis. Treatment of such waste solutions is generally carried out by neutralization with a basic material, such as lime or limestone. The resultant slurry contains iron hydroxide, calcium and magnesium sulphates, and calcium and magnesium hydroxides. With the exception of magnesium sulphate, these products are all relatively insoluble and must be removed before discharging the clear solution into waterways or sewer lines.

Difficulty is encountered in this separation, whether carried out by filtration or settling methods, because of the low settling rates, the poor filtering characteristics, the large volume of material involved, and the high solution content retained by the solids. The problem of the operator of the neutralizing plant is the problem of obtaining the best conditions for most rapid settling or filtration of the neutralized slurry, and the other factors noted above, together with the least time required for neutralization, all consistent with economical operation. In regard to these factors, it is possible to effect an improvement by proper choice of lime composition.

Figure 1 — Variation of pH of slurry filtrate with the time after the start of mixing.



The purpose of the present investigation has been to study the effect of the CaO:MgO ratio in the lime used for waste pickle liquor neutralization on the rate of the neutralization reaction and the filtering characteristics of the neutralized slurry, including cake volume, filtration rates and cake resistivity.

EQUIPMENT AND PROCEDURE

For the purposes of this investigation, a synthetic waste pickle liquor containing 120 grams $FeSO_4$ per liter and 120 grams H_2SO_4 per liter (or approximately 10 per cent $FeSO_4$ — 10 per cent H_2SO_4 — 80 per cent H_2O by weight) was prepared by dissolving $FeSO_4.7H_2O$ crystals and sulphuric acid in distilled water. The lime slurry for neutralization was prepared from calcium oxide and magnesium oxide powders mixed in the proper ratio. For each 300-ml sample of waste pickle liquor used in a single run, the lime used was 10 per cent in excess of the stoichiometric amount required and was slaked in 200 ml of distilled water immediately prior to its use.

After slaking the lime for one-half hour, the lime slurry was added slowly to the waste pickle liquor, thorough agitation of the mixture being provided. Neutralization was carried out in a beaker which was kept lightly covered in order to minimize oxidation of the ferrous to the ferric ion by the air. No attempt was made to control the temperature during neutralization at some fixed value, and an increase in the temperature of the mixture above room temperature resulted from the release of energy by the neutralization reaction.

The course of the reaction was followed by measuring the pH of the solution at intervals of time. This was done by removing samples of the mixture, filtering and testing the filtrate with pHydrion paper.

When steady state conditions were obtained, the rate of flow of filtrate through the cake was measured by noting the time required to collect a given volume of filtrate in the graduated cylinder. The thickness of the cake was measured by the scale attached to the apparatus and the pressure drop across the cake was measured by the U-tube mercury manometer.

Following this procedure, the needle valve was partially closed, thereby increasing the pressure drop across the cake. Filtration was allowed to proceed, returning filtrate as before, until steady state conditions were again reached. New values for the rate of filtration, cake thickness and pressure drop were then determined. This procedure was repeated at successively higher pressure drops until the highest pressure drop obtainable with the apparatus was reached.

RATE OF THE NEUTRALIZATION REACTION

The time required for the reaction between lime slurry and waste pickle liquor to reach completion was found to be appreciably increased as the CaO:MgO ratio of the lime mixture was decreased.

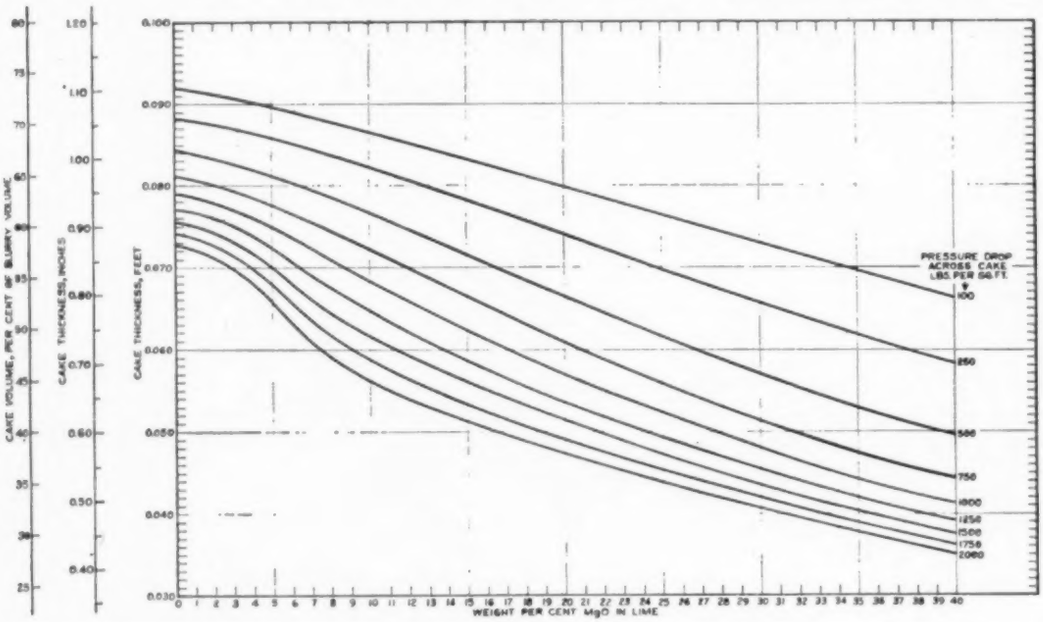


Figure 2 — Variation of cake thickness with lime composition for lines of constant pressure drop across cake.

The general variation of pH with the time after the start of mixing the waste pickle liquor and lime slurry is shown in Figure 1 which presents the data of runs D-5 and D-6. Results indicate that the time required to reach a pH of 7 under the conditions of the experiment varied with the MgO content of the lime as follows:

CaO:MgO ratio	Time to reach pH of 7 in minutes
100:0	90–95
98.55:1.45	100–110
97.09:2.91	205–215
95.61:4.39	325–335
94.12:5.88	(not reached in 500 minutes)

For MgO contents greater than 4.39 per cent by weight, a pH of 7 was not reached during the period for which the tests were run.

In practice, individual limes will be found to exhibit different reactivities when applied to the neutralization of steel mill waste pickle liquor. Local operating con-

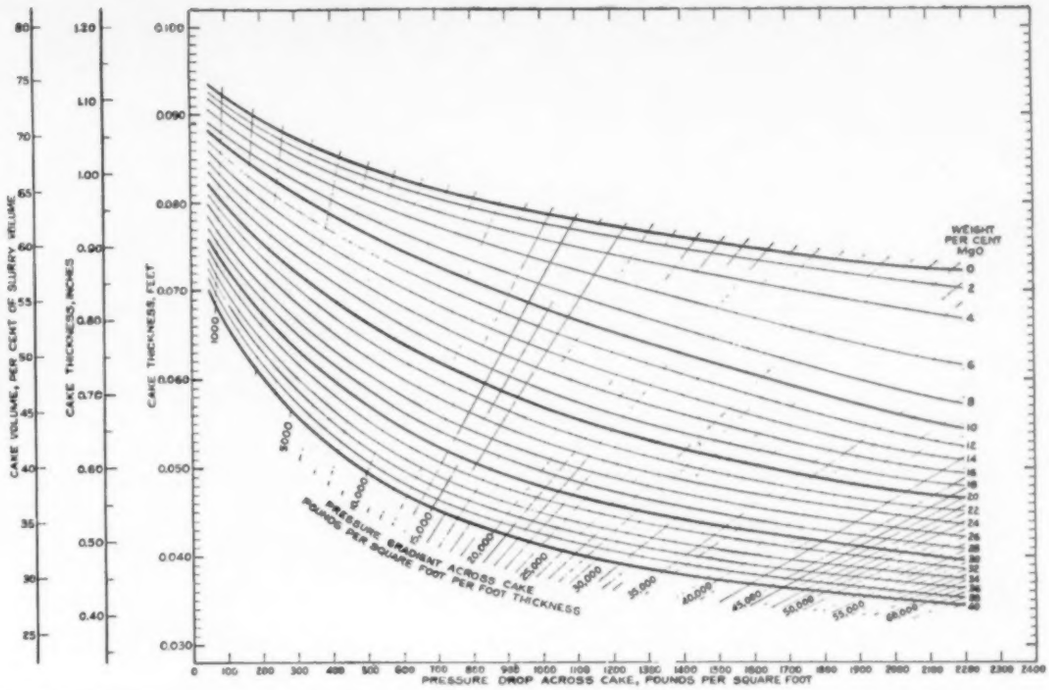

CAKE VOLUME, PER CENT OF SLURRY VOLUME
CAKE THICKNESS, INCHES
CAKE THICKNESS, FEET
WEIGHT PER CENT MgO
PRESSURE GRADIENT ACROSS CAKE POUNDS PER SQUARE FOOT PER FOOT THICKNESS
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT

Figure 3 — Variation of cake thickness with pressure drop across cake for lines of constant lime composition.

ditions, such as the analysis of the waste pickle liquor, per cent excess lime used, slaking conditions and so forth will also affect the rate of neutralization. Temperature, too, has an appreciable effect, and if the steel mill waste pickle liquor is received at the neutralizing site at the same temperature as the pickling temperature for steel (approximately 200–220 F), the time required for neutralization will be considerably reduced below the figures given above. In general, the use of lime of high CaO content should be preferred from the standpoint of reducing the time required for the neutralization reaction.

VOLUME OF FILTER CAKE PRODUCED

The volume of filter cake produced from the filtration of the neutralized waste pickle liquor slurry was found to vary with both the composition of the lime mixture used for neutralization and the pressure drop across the cake during filtration in the manner shown in Figures 2, 3 and 4

Figure 2 shows the variation of cake thickness with lime composition for lines of constant pressure drops across the cake. Figure 3 shows the variation of cake

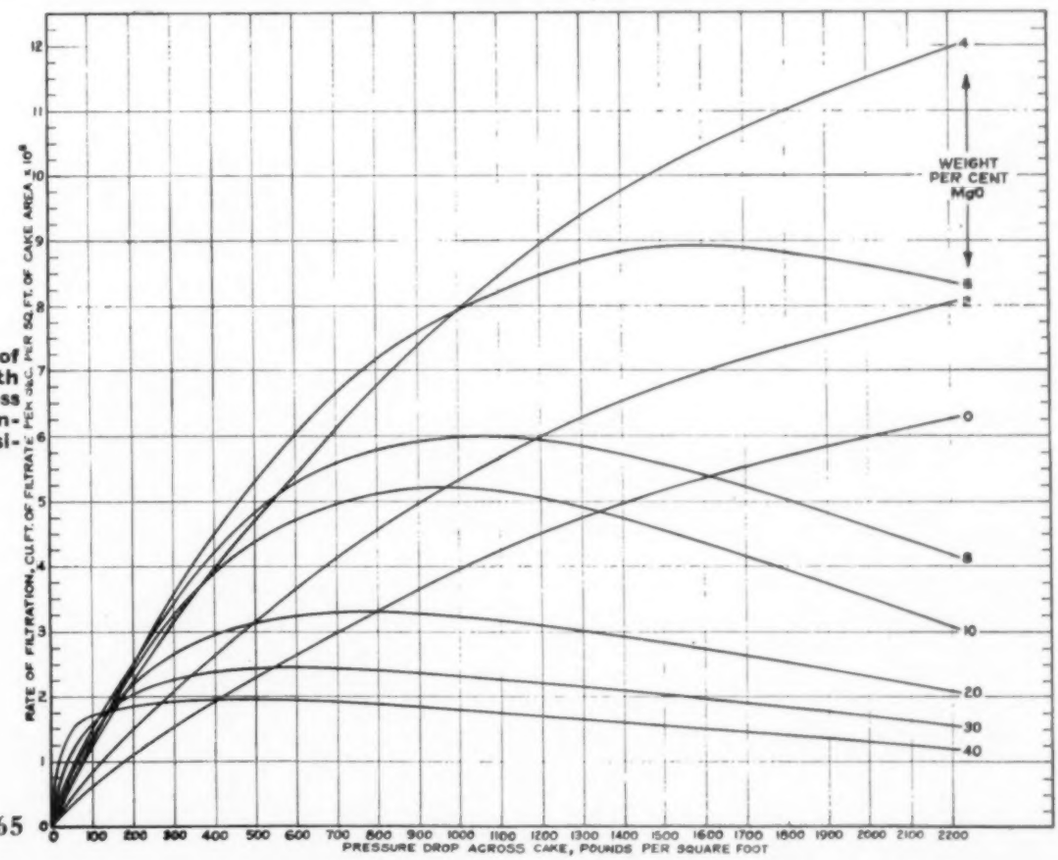

RATE OF FILTRATION, CU.FT. OF FILTRATE PER SEC. PER SQ.FT. OF CAKE AREA x 10⁴
WEIGHT PER CENT MgO
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT

Figure 4 — Variation of rate of filtration with pressure drop across cake for lines of constant lime composition.

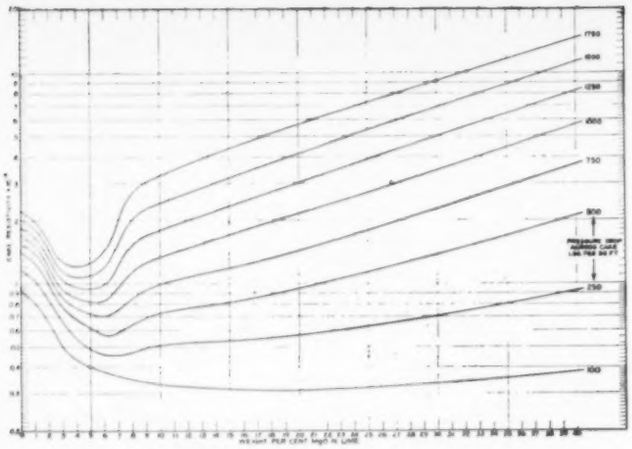


Figure 5 — Variation of cake resistivity with lime composition for lines of constant pressure drop across cake.

thickness with pressure drop across the cake for lines of constant lime composition, and includes lime compositions covered in the range studied.

As the cross-sectional area of the cake was the same for all runs, the variation of cake volume is exactly parallel to the variation in cake thickness. The auxiliary scale at the left of Figure 2 and 3 gives the cake volume as expressed as a per cent of the slurry volume, and is of assistance in predicting the volume of cake to be produced under known conditions. The volume of filtrate is equal to the difference between the original volume of slurry and the cake volume.

For a given lime composition, the decrease in cake thickness accompanying an increase in pressure drop across the cake is identified with a decrease in the porosity (the fraction of void space) of the cake.

For a given pressure drop, the decrease in cake thickness as the MgO content of the lime mixture was increased is largely the result of the difference of solubilities of $MgSO_4$ and $CaSO_4$, which are formed as products of the neutralization reaction. Since $MgSO_4$ is highly soluble and $CaSO_4$ relatively insoluble in water, the effect of using lime of high MgO content (low CaO:MgO ratio) is simply to reduce the amount of solids present in the slurry and, therefore, in the cake. Hence, filtering equal volumes of slurry results in more cake and less filtrate in the case of lime of high CaO content than in the case of lime of high MgO content.

Following an initial compression for small pressure drops across the cakes, the cakes corresponding to high CaO content exhibit a more nearly constant thickness than those cakes corresponding to high MgO content, which continue to compress markedly with increasing pressure drop. An appreciable change in this feature is observed in the neighborhood of 4 to 6 per cent MgO by weight.

Besides having an effect on the rate of filtration, the compression of the cake would be expected to have an effect on the development of cracks in the cake. In practical applications of vacuum filtration, crack formation during the dewatering cycle results in air leakage which increases the power requirements for maintaining the vacuum. In all but a few experimental runs, cracks

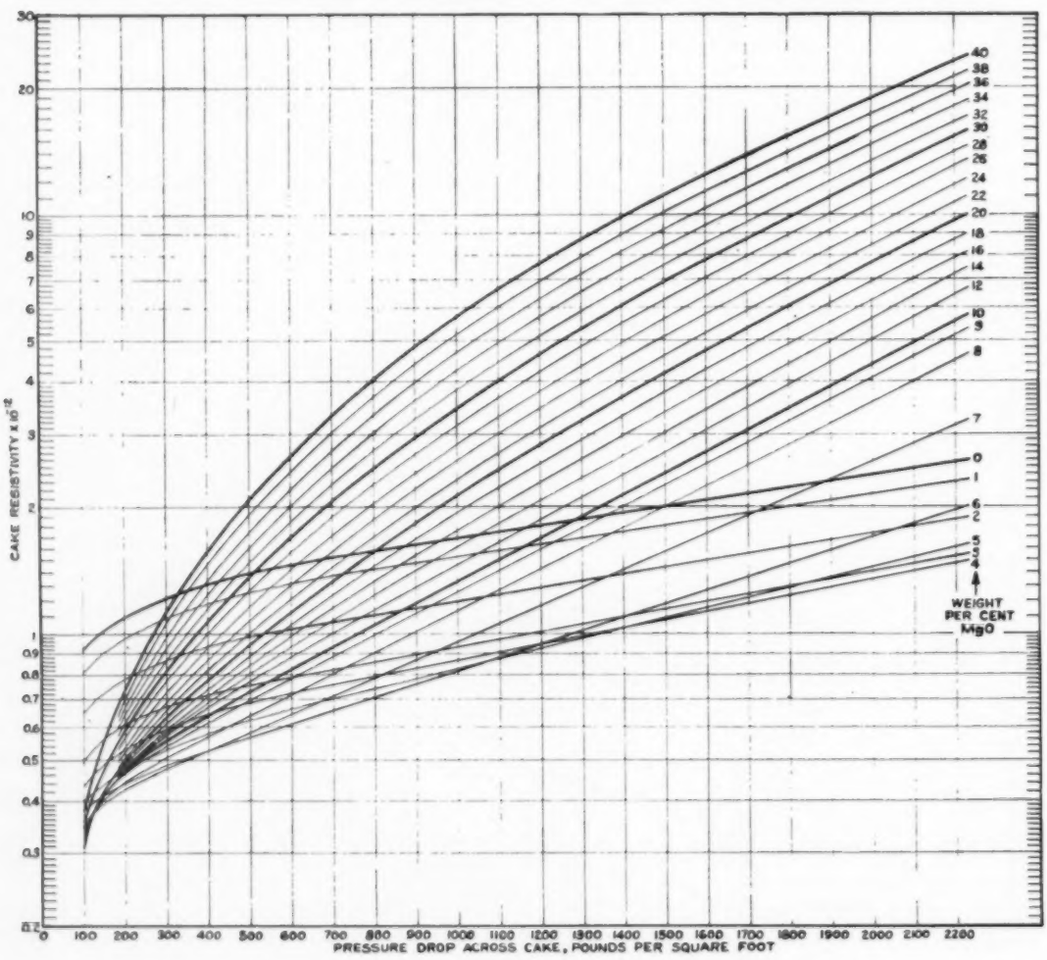


Figure 6 — Variation of cake resistivity with pressure drop across cake for lines of constant lime composition.

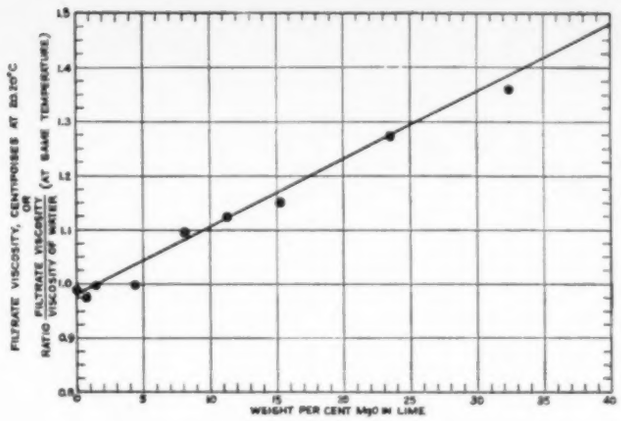

FILTRATE VISCOSITY, CENTIPOISES AT 23.2°C OR RATIO FILTRATE VISCOSITY (AT SAME TEMPERATURE) VISCOSITY OF WATER
WEIGHT PER CENT MgO IN LIME

Figure 7 — Variation of filtrate viscosity with lime composition.

did not develop in the cakes until the dewatering period. In some cases prior to dewatering, shrinkage of the cake occurred in which the cake pulled away from the wall, and this behavior occurred most often for cakes of high MgO content. All cakes, whether formed from lime of high or low MgO content, developed cracks during dewatering.

RATE OF FILTRATION

The rate at which a given slurry can be filtered is the most important factor in limiting the capacity of filtration equipment. The variation in the rate of filtration with the pressure drop across the cake is shown in Figure 4 for lines of constant lime composition. The curves of Figure 4 are plotted for the amount of cake deposited from the same amount of slurry (an amount sufficient to give a slurry column of 1.50 inches height in the filtration apparatus) in all cases. The actual thickness of this cake can be found from Figure 3 for any case desired.

Figure 4 shows that the rate of filtration does not increase linearly with the pressure drop across the cake, as would be expected of a non-compressible cake. Also, as the per cent of MgO in the lime mixture is increased, the curves exhibit a maximum point, after which the rate of filtration decreases with further increase in the pressure drop across the cake. From such behavior, it is apparent that the resistance of the cake to filtration is increasing with the pressure drop at a faster rate than the rate of filtration.

Figure 4 further indicates that there exists an optimum lime composition of approximately 4 per cent MgO by weight for obtaining the maximum rates of filtration. Figure 4 indicates that commercial dolomitic limes, which are commonly used for neutralization because of their lower cost as compared to high calcium limes, give decidedly lower rates of filtration than the high calcium limes (neglecting effects of inerts).

CAKE RESISTIVITY

As the term itself suggests, "cake resistivity" is a measure of the resistance offered by the cake to the flow of filtrate through it. The mathematical significance of the term cake resistivity, denoted by the symbol α, is readily demonstrated. Thus, as applied to filtration, the general rate of flow equation

$$\text{Time rate of flow} = \frac{\text{Driving force causing flow}}{\text{Resistance to flow}}$$

may be written in the form:

$$\frac{dV}{d\theta} = \frac{A\Delta P}{\mu \alpha L} \qquad (5)$$

where V = volume of filtrate
θ = time
ΔP = pressure drop across cake
A = area of cake perpendicular to the direction of flow
L = thickness of cake parallel to the direction of flow
μ = viscosity of filtrate

Rearranging equation (5)

$$\alpha = \frac{\dfrac{\Delta P}{L}}{\dfrac{dV}{A d\theta}} \left(\frac{1}{\mu} \right) \qquad (6)$$

α = pressure drop per unit cake thickness divided by both the rate of flow of filtrate per unit cake area and the viscosity of the filtrate

This derivation indicates the method used to calculate values of cake resistivity. Thus, at each pressure drop across the cake, the steady state values for ΔP, L, A and $dV/d\theta$ (where $dV/d\theta = (V - V_o)/(\theta - \theta_o)$ because of the steady state conditions) were measured and substituted into equation (6), along with the measured value of the viscosity of the filtrate, to obtain the cake resistivity.

While mathematically the term cake resistivity has the significance of a proportionality "constant," it is seen from Figure 5 and 6 that the cake resistivity is not truly constant for a given cake (corresponding to given lime composition) but varies considerably with the pressure drop across the cake. Figure 5 shows the variation of cake resistivity with lime composition for lines of constant pressure drop across the cake, while Figure 6 shows the variation of cake resistivity with pressure drop across the cake for lines of constant lime composition. These two figures are obtained from plots of the data for runs of constant lime composition.

The significant feature to be noted in Figure 5 is the existence of a minimum in the curve at a lime composition of approximately 4 per cent MgO by weight. This is approximately the same lime composition at which the rate of filtration is greatest (Figure 4) and at which the change in cake thickness with pressure drop undergoes an appreciable change in behavior (Figure 2 and 3).

Figures 5 and 6 were plotted on semi-logarithmic paper rather than the ordinary rectangular coordinate paper in order to retain the same relative accuracy at low values of cake resistivity as at the high values. This was occasioned by the almost hundred-fold variation in cake resistivity values. This manner of plotting revealed the straight line relationship between the logarithm of the cake resistivity and the pressure drop across the cake for the latter portions of the curve (i.e. high pressure drops) and for lime compositions

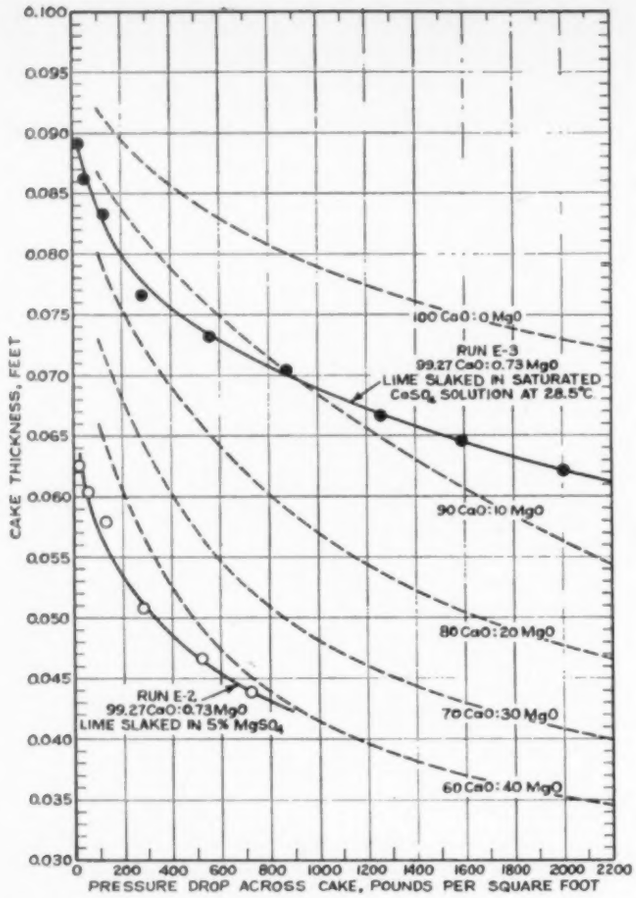

CAKE THICKNESS, FEET
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT
100 CaO : 0 MgO
RUN E-3
99.27 CaO : 0.73 MgO
LIME SLAKED IN SATURATED
CaSO4 SOLUTION AT 28.5°C
90 CaO : 10 MgO
80 CaO : 20 MgO
70 CaO : 30 MgO
60 CaO : 40 MgO
RUN E-2
99.27 CaO : 0.73 MgO
LIME SLAKED IN 5% MgSO4

Figure 8 — Variation of cake thickness with pressure drop across cake for different slaking media.

from 0 to 15 per cent MgO by weight. Deviations from the straight line relation are seen to be more pronounced as the MgO content of the lime is increased. This behavior was unexpected, and disagrees with the behavior of cake resistivity and pressure drop predicted from the relation commonly given in the literature. As it appears in Perry's Chemical Engineers' Handbook, pp 965, this relation is given by the equation:

$$\alpha = \alpha' p^s \qquad (7)$$

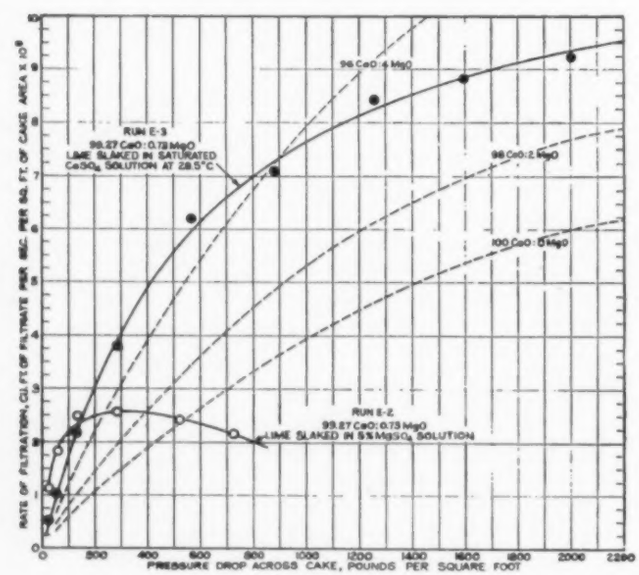
where α = cake resistivity (or average specific cake resistance)

p = pressure drop through the filter medium and the cake upon it

s = the cake compressibility, varying from 0 for rigid, incompressible cakes to 1.0 for very highly compressible cakes

α' = a constant determined largely by the size of particles forming the cake

Figure 9 — Variation of rate of filtration with pressure drop across cake for different slaking media.


RATE OF FILTRATION, CU FT OF FILTRATE PER SEC. PER SQ. FT. OF CAKE AREA x 10⁴
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT
RUN E-3
99.27 CaO : 0.73 MgO
LIME SLAKED IN SATURATED
CaSO4 SOLUTION AT 28.5°C
RUN E-2
99.27 CaO : 0.73 MgO
LIME SLAKED IN 5% MgSO4 SOLUTION

While cake resistivity has heretofore been discussed from the standpoint of its significance as a mathematical constant of proportionality in equation (5), it has the physical significance of measuring the resistance to filtration as characterized by the nature of the cake material, as distinguished from the resistance resulting from the amount of cake (e.g. cake thickness L and cake area A) and that due to the viscosity of the filtrate, μ. For reference, the change of filtrate viscosity with lime composition is shown in Figure 7 and for convenience is expressed as a multiple of the viscosity of water at the same temperature. It is seen that the filtrate viscosity increases with decreasing CaO:MgO ratio due to increases in the amount of dissolved material, magnesium sulphate, in the filtrate. The changes in the values for cake thickness and filtrate viscosity with change in lime composition are such as to oppose each other in their effect on the rate of filtration and could thus account for the existence of an optimum lime composition for obtaining the highest rate of filtration. The magnitudes of these changes are not sufficient to explain the very large differences noted between the curves of Figure 4. The fact that the slurry produced from a 4 per cent MgO lime filters five times as rapidly as that produced from other lime compositions must be explained on the basis of cake resistivity rather than cake thickness or filtrate viscosity.

In a compressible cake of the type under discussion, the value of the cake resistivity and its change with increasing pressure drop across the cake is thought to depend upon (1) the ratio of compressible (e.g. iron hydroxide) to non-compressible (e.g. calcium sulphate) material in the cake, and (2) the particle characteristics, such as size and shape.

The first factor, the ratio of compressible to non-compressible material in the cake, would seem to be largely determined by the CaO:MgO ratio in the lime mixture used for neutralization, other factors being equal. For a lime composition of 0 per cent MgO, the amount of crystalline calcium sulphate in the cake is a maximum. As the MgO content of the lime is raised, less calcium sulphate appears in the cake and the ratio of compressible to non-compressible material in the cake (the amount of iron hydroxide being approximately constant) is increased. Thus, for decreasing CaO:MgO ratio, one should expect the following behavior in cake thickness: (1) a smaller volume of cake at any given pressure drop, and (2) a greater relative compression in the cake as the pressure drop is increased which is the behavior noted in Figure 3. Applying these same considerations to cake resistivity, the relations are not as simple as in the case of cake thickness. The existence of the minimum in the curve of cake resistivity

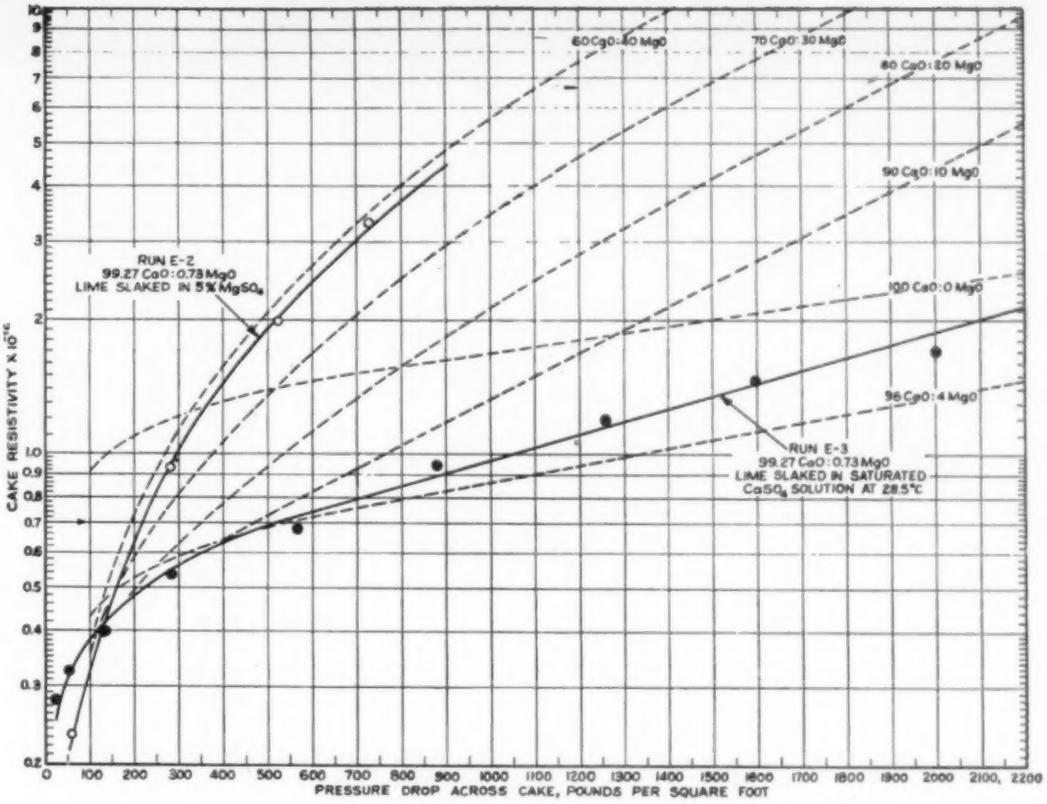

60 CaO: 40 MgO
70 CaO: 30 MgO
80 CaO: 20 MgO
90 CaO: 10 MgO
100 CaO: 0 MgO
96 CaO: 4 MgO
RUN E-2
99.27 CaO: 0.73 MgO
LIME SLAKED IN 5% MgSO4
RUN E-3
99.27 CaO: 0.73 MgO
LIME SLAKED IN SATURATED
CaSO4 SOLUTION AT 28.5°C
CAKE RESISTIVITY X 10^10
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT

Figure 10 — Variation of cake resistivity with pressure drop across cake for different slaking media.

vs lime composition (Figure 5) requires the consideration of the particle characteristics, such as size and shape, of the material in the cake.

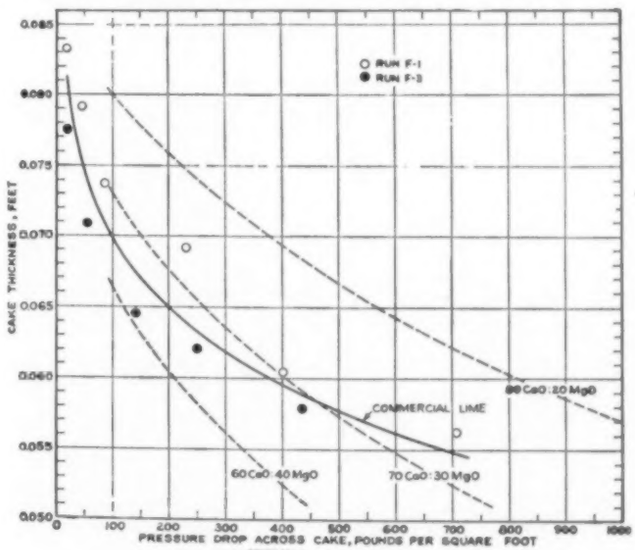
USE OF FILTRATE FOR SLAKING

A variable which may affect particle size and shape, as reflected in cake resistivity values, is the use of filtrate from one run to slake the lime for use in a succeeding run. Such use has the advantage, in a practical application, of reducing the amount of liquid material discharged from the treating plant. At the pilot plant of the Marblehead Lime Co. in South Chicago, Ill., such practice, applied to commercial conditions, gave the following results: less filtrate was required to slake a given amount of lime than water, and a more readily filterable sludge was produced with a heavier and drier cake. The report gives the opinion that the calcium sulphate in the filtrate (which, from solubility considerations, must be small) was responsible for the improvements noted. These tests were conducted with a high calcium lime analyzing 1 to 1½ per cent MgO by weight.

In order to investigate this effect, two samples of a lime mixture with a CaO:MgO ratio of 99.27:0.73 parts by weight were slaked in saturated calcium sulphate solution and 5 per cent magnesium sulphate solution, and were then used to neutralize the waste pickle liquor, as before. The results of these two tests (Run Nos. E-2 and E-3) are shown in Figures 8, 9 and 10. These figures show the variation of cake thickness, rate of filtration and cake resistivity, respectively, with pressure drop across the cake for both slaking conditions as compared with the averaged experimental results for different lime mixtures slaked in distilled water. These figures show that slaking in saturated calcium sulphate solution gives a definite improvement in the filtering characteristics of the neutralized slurry; the rate of filtration, for example, is increased about 40 per cent over that obtained by slaking in water. On the other hand, slaking in a 5 per cent magnesium sulphate solution results in a slurry with considerably lower filtration rate and a cake of high resistivity.

In connection with these tests, it was observed that the lime mixture did not seem to slake completely in the saturated calcium sulphate and 5 per cent magnesium sulphate solutions, as noted by the small increase in the temperature of the slaking medium during slaking. Also, whereas a pH of 7 was obtained after about

Figure 11 — Variation of cake thickness with pressure drop across cake for commercial lime.



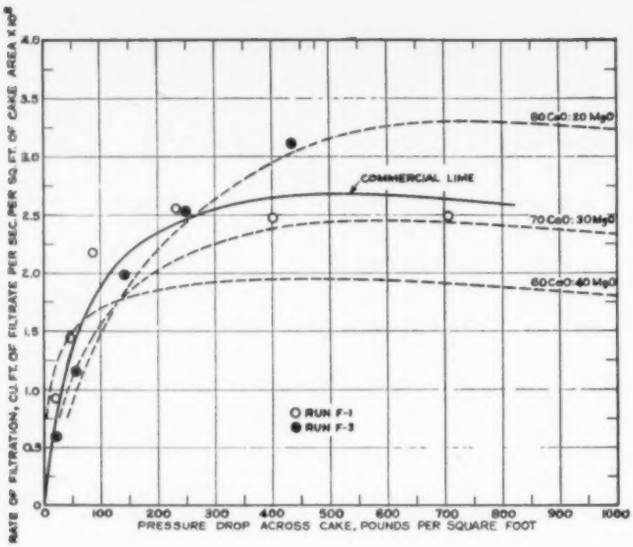
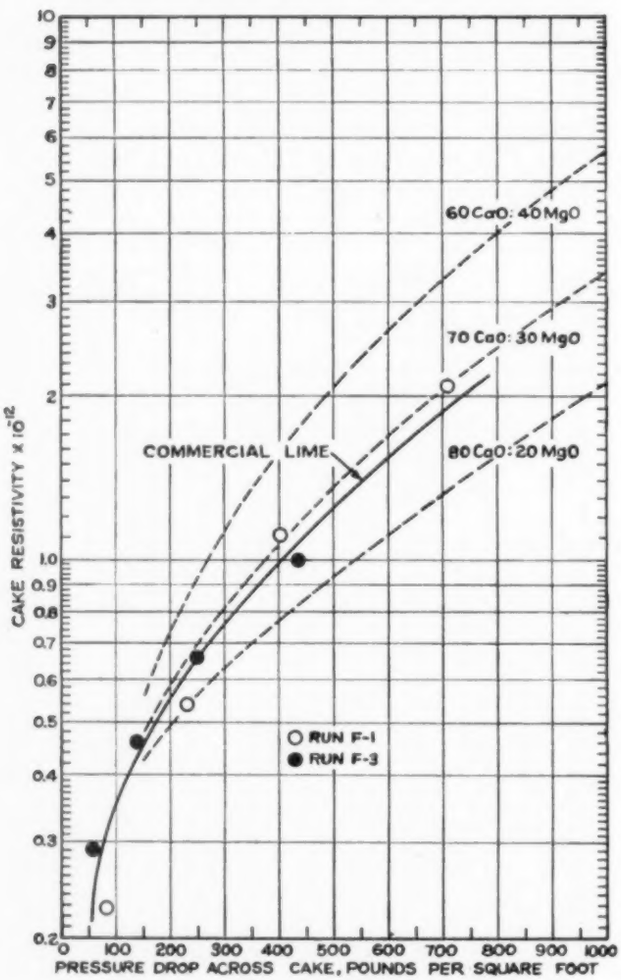

RATE OF FILTRATION, CU. FT. OF FILTRATE PER SEC. PER SQ. FT. OF CAKE AREA X 10³
80 CaO: 20 MgO
COMMERCIAL LIME
70 CaO: 30 MgO
60 CaO: 40 MgO
O RUN F-1
● RUN F-3
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT

Figure 12 — Variation of rate of filtration with pressure drop across cake for commercial lime.

100 minutes of mixing the lime slurry and waste pickle liquor when the lime was slaked in distilled water, a pH of 7 was not reached even after 4 hours of mixing when the same lime mixture was slaked in the saturated calcium sulphate and 5 per cent magnesium sulphate solutions. Further study using more than 10 per cent excess lime and a higher temperature might give neutralization to a pH of 7.

Figure 13 — Variation of cake resistivity with pressure drop across cake for commercial lime.


CAKE RESISTIVITY X 10¹²
60 CaO: 40 MgO
70 CaO: 30 MgO
COMMERCIAL LIME
80 CaO: 20 MgO
O RUN F-1
● RUN F-3
PRESSURE DROP ACROSS CAKE, POUNDS PER SQUARE FOOT

COMMERCIAL LIME

In order to compare the results for lime mixtures made from chemically pure calcium oxide and magnesium oxide powders with the results for commercial limes, a sample of commercial dolomitic hydrated lime with the following reported analysis was obtained:

43.5 per cent CaO
30.1 per cent MgO
26.4 per cent Inert matter
CaO:MgO ratio = 59.1:40.9 parts by weight

This lime was tested in the same manner as the lime mixtures previously discussed (slaked in water). The results of two trials (Run Nos. F-1 and F-3) are shown in Figures 11, 12 and 13. These figures show the variation of cake thickness, rate of filtration and cake resistivity, respectively, with pressure drop across the cake for the commercial lime as compared with the averaged experimental results for different lime mixtures. While it was not expected that the results for mixtures prepared from chemically pure calcium oxide and magnesium oxide powders would match those for commercial material, Figures 11, 12 and 13 show the results to be surprisingly close.

Unfortunately no tests were made with high calcium lime of commercial grade in order to complete the comparison, as such samples were not immediately available. While one hesitates to offer conclusions based on results from a single sample, it appears that slurries produced by neutralization with commercial grade limes will behave similar to slurries for mixtures of calcium oxide and magnesium oxide powders of approximately the same CaO:MgO ratio.

SUMMARY OF CONCLUSIONS

Based on the results obtained in the present investigation, the following conclusions are offered regarding the effect of the CaO:MgO ratio in the lime used for the neutralization of steel mill waste pickle liquor:

1. The time required for the neutralization reaction to be completed is appreciably increased as the CaO:MgO ratio in the lime is decreased.
2. The volume of filter cake is decreased as the CaO:MgO ratio in the lime is decreased.
3. There exists an optimum CaO:MgO ratio for obtaining the highest rates of filtration of the neutralized slurry. For the pressure drops used in practical applications, this optimum CaO:MgO ratio is approximately 96:4 parts by weight.
4. A commercial lime gave results that are closely comparable with those from mixtures of calcium oxide and magnesium oxide of the same CaO:MgO ratio.
5. Slaking the lime in saturated calcium sulphate solution gives better filtering characteristics of the neutralized slurry, while slaking in magnesium sulphate solution gives poorer filtering characteristics of the neutralized slurry for lime of high CaO:MgO ratio.

PROGRAM

ANNUAL SPRING CONFERENCE

SPONSORED BY

The Rolling Mill Committee

OF THE

ASSOCIATION OF IRON AND STEEL ENGINEERS

NETHERLAND PLAZA HOTEL

CINCINNATI, OHIO

APRIL 28 - 29, 1952

EDWARD T. PETERSON

Annual Spring Conference

PROGRAM

MONDAY, APRIL 28, 1952

9:00 a.m. — Registration — Fourth Floor Foyer

9:30 a.m. — Rolling Mill Session — Pavillon Caprice

Co-Chairmen:
T. M. Fairchild, Superintendent Franklin Mills
Bethlehem Steel Co.

Wade Hoffman, Superintendent Roll Department
Jones & Laughlin Steel Corp.

1. "Two-High Reversing Mills for the Rolling of Semi-Finished Products"
   Edward T. Peterson, Vice President Engineering
   Lewis W. King, Manager, Roll Sales
   Edward C. Peterson, Engineer
   Birdsboro Steel Foundry and Machine Co.
   Reading, Pa.
2. "Increasing the Productivity of Fontana Blooming Mill"
   William A. Vogt, Project Engineer
   Kaiser Engineers, Inc.
   Oakland, Calif.
3. "Factors Which Influence the Surface Quality of High Sulphur Steel"
   George G. Blean, Steel Works Metallurgist
   Jones & Laughlin Steel Corp.
   Pittsburgh, Pa.

WILLIAM A. VOGT

9:30 a.m. — Electrical Session — Parlors A–B–C–D

Co-Chairmen:
James D. O'Roark
Weirton Steel Co.

Roland Hess
Armco Steel Corp.

1. "Inertia Studies for Modern Mill Drives"
   J. F. Sellers, Engineer-in-Charge, D-C Motor & Generator Design
   T. B. Montgomery, Engineer-in-Charge, Control Design
   Allis-Chalmers Manufacturing Co.
   Milwaukee, Wisc.
2. "Application and Control of A-C Motors for Intermittent Loads"
   R. H. Wright
   Westinghouse Electric Corp.
   East Pittsburgh, Pa.
3. "Selection and Analysis of Regulating Systems for Mill Drives"
   W. E. Miller
   and
   F. S. Rothe
   General Electric Co.
   Schenectady, N. Y.

GEORGE G. BLEAN

J. F. SELLERS

T. B. MONTGOMERY

R. H. WRIGHT

W. E. MILLER

LEWIS W. KING

EDWARD C. PETERSON

CHAS. C. HILL, JR.

HARRY GILCHRIST

2:00 p.m. — Rolling Mill Session — Pavillon Caprice

Co-Chairmen:
Alex Montgomery, Jr.
United States Steel Co.

Louis Moses
Bethlehem Steel Co.

1. "Identification Marking of Blooms, Billets, and Slabs"
   Charles C. Hill, Jr., Assistant to Chairman Rolling Mill Committee
   United States Steel Co., Pittsburgh, Pa.
2. "Operation and Roll Design of the Gary Rail Mill"
   R. W. Dickson, Division Superintendent, Central Mills
   United States Steel Co., Gary, Ind.
3. "Pass Design for Hexagons"
   H. E. Muller, Assistant Superintendent, Roll Department
   Inland Steel Co., Indiana Harbor, Ind.

H. F. JACQUART

2:00 p.m. — Mechanical Session — Parlors A–B–C–D

Co-Chairmen:
Emil Kern
Allegheny Ludlum Steel Corp.

J. B. Whitlock
Armco Steel Corp.

1. "Various Applications for Composition Non-Metallic Bearings"
   Harry Gilchrist, Lubrication Engineer
   K. W. Atwater Engineering, Inc., Pittsburgh, Pa.
2. "New Installations and Developments for Increased Capacity"
   G. D. Tranter, Manager, Middletown Division
   Armco Steel Corp., Middletown, Ohio
3. "Planned Maintenance of Blooming Mills"
   H. F. Jacquart, Master Mechanic, Blooming Mills
   Jones & Laughlin Steel Corp., Pittsburgh, Pa.

G. D. TRANTER

7:00 p.m. — Informal Dinner — Hall of Mirrors (3rd Floor)
An address by W. W. Sebald, President
Armco Steel Corp.

(Program continued on next page)

R. W. DICKSON

F. S. ROTHE

H. E. MULLER

W. W. SEBALD

H. H. WARNOCK

J. L. HOLMQUIST

J. L. WHITTEN

TUESDAY, APRIL 29, 1952

9:00 a.m. — Rolling Mill Session — Pavillon Caprice

Co-Chairmen:
D. W. Lloyd
Youngstown Sheet and Tube Co.

J. N. Imel
Jones & Laughlin Steel Corp.

1. "Accident Control in Rolling Mills"
   Carter Kendall, Chief Safety Engineer
   Bethlehem Steel Co.
   Bethlehem, Pa.
2. "Design and Operation of a Four-Stand Semi-Continuous Hot Strip Mill"
   H. H. Warnock, Superintendent Strip and Bar Mills
   Youngstown District
   Republic Steel Corp.
   Youngstown, Ohio
3. "Investigation of Material Displacement in Mannesmann Piercing by Means of Model Wax Billets"
   J. L. Holmquist, Director of Research
   Spang Chalfant Division
   National Supply Co.
   Ambridge, Pa.

9:00 a.m. — Combustion Session — Parlors A–B–C–D

Co-Chairmen:
E. T. W. Bailey
Steel Co. of Canada, Ltd.

George H. Krapf
United States Steel Co.

1. "Single Stack High Convection Annealing for Narrow Steel Strip"
   J. L. Whitten, Vice President
   Lee Wilson Engineering Co., Inc.
   Cleveland, Ohio
2. "Steel Defects Commonly Attributed to Heating"
   George Y. Boal, Supervisor of Metallurgical Control
   Crucible Steel Co. of America
   Midland, Pa.
3. "Automatic Controls for Regenerative Soaking Pits"
   Griffin L. Isaacs, Assistant to Superintendent of Blooming Mills
   United States Steel Co.
   Duquesne Works
   Duquesne, Pa.

1:00 p.m. — INSPECTION TRIP —
Armco Steel Corp., Middletown, Ohio

Trip must be made on authorized buses which will leave from Netherland Plaza Hotel.

GEORGE Y. BOAL

GRIFFIN L. ISAACS

HOTEL RESERVATIONS

Hotel reservations should be made direct to Manager of Reservations, Netherland Plaza Hotel, Cincinnati 1, Ohio, giving time of arrival and type of accommodations desired. Reservations should state that they are for AISE Spring Conference.

Has Industrial Tractor Design Kept Pace

WITH STEEL MILL OPERATING REQUIREMENTS?

By CARLETON LORD
Materials Handling Engineer
United States Steel Co.
Pittsburgh, Pa.

. . . . the primary requirement for which industrial tractors should be designed, as far as the steel industry is concerned, is safety . . . .

▲ THE industrial tractor has proved itself to be one of the most useful and versatile pieces of materials handling equipment that can be found in a steel mill. Available in a wide variety of types and sizes, its applications are virtually unlimited.

The employment of tractors in steel-making operations has shown extraordinary growth during the past 20 years. From a very modest beginning, where tractors were engaged in isolated activities, their use has spread to nearly every department, and hardly a month passes without some additional application.

Considering the current popularity of industrial tractors, this may seem hardly an opportune time to raise the question of whether tractor design has kept pace with the operating requirements of the modern steel mill. It may well be argued that the wide acceptance of the tractor is adequate evidence of its adaptability to the many operations in which it presently is engaged. If it were not a good piece of equipment, certainly its use would be restricted rather than expanded.

However, a study of tractor applications in steel mills suggests that tractor manufacturers are now faced with a challenging problem in design. Upon their answer may well depend the extent to which tractors will be used in the future by the steel industry.

In the design evolution of the tractor as we know it today, emphasis has been placed largely on meeting the mill demands for capacity, maneuverability and flexibility. In this respect, the results have been generally satisfactory. It seems appropriate to determine whether the same design ingenuity has been applied as successfully to the very important matter of safe operation.

It is obvious that tractor design cannot stop with the mere provision of a unit capable of picking up and moving a designated load. If the use of such equipment offers any unusual hazard to the operator, or to persons working in the area where it is being used, then the tractor manufacturer has failed in one of the most essential design requirements. If the tractor is not completely safe to operate, it cannot meet present-day steel mill operating requirements.

It may be well to mention at this point that the term "tractor," as used in this paper, is peculiar to steel companies. In other industries, the term "industrial trucks" applies to the same type of equipment, and in

Figure 1 — Tractor shown has very little visibility.

Figure 2 — Excellent visibility is afforded by this unit.

this elassification we find fork and ram trucks, straddle trucks, and platform trucks. In the steel industry, the same equipment is referred to as fork and ram tractors, straddle tractors and platform tractors.

The steel industry today has an excellent safety record. This did not just happen. It began with the sincere conviction that the preservation of life and the prevention of injuries is a subject worthy of the finest talents in the industry. It resulted from endless hours of research, from vast expenditures of time and money, and from constant effort at all levels of management.

It follows that those of us charged with the selection of materials handling equipment have a grave responsibility for the safety and welfare of employees who work with and near this equipment. Despite what we may have done in the past, and regardless of what we do in the future, as long as tractors are involved in accidents—even a single accident—our efforts will be judged as having been inadequate.

A detailed analysis of the principal causes of tractor accidents is not under discussion here, although it may be said that the most common causes can be grouped in four basic classes:

1. *Human failures*, such as poor judgment, carelessness, inadequate training, lack of experience, and violation of safety rules.
2. *Unsafe physical conditions*, including crowded aisles, uneven floors, blind corners, poor housekeeping, and limitations imposed by plant construction and layout.
3. *Unsafe mechanical conditions*, such as inadequate maintenance and mechanical failures.
4. *Faulty basic design*, which may include poor visibility, lack of proper safeguards, and inadequate mechanical strength.

All of these have been, and can be, contributing factors, and all must be reviewed in any investigation of lost-time and fatal accidents.

At a recent meeting of the Seven Company Exchange, safety executives representing the principal steel producers reviewed records of accidents in which tractors were involved. It was agreed that a careful check on all phases of tractor operation was essential, and top priority was given to a constructive program to improve the safety characteristics of tractor design. Development of this project has been undertaken by the United States Steel Co.

Figure 3 — Framework blocks vision on this unit.

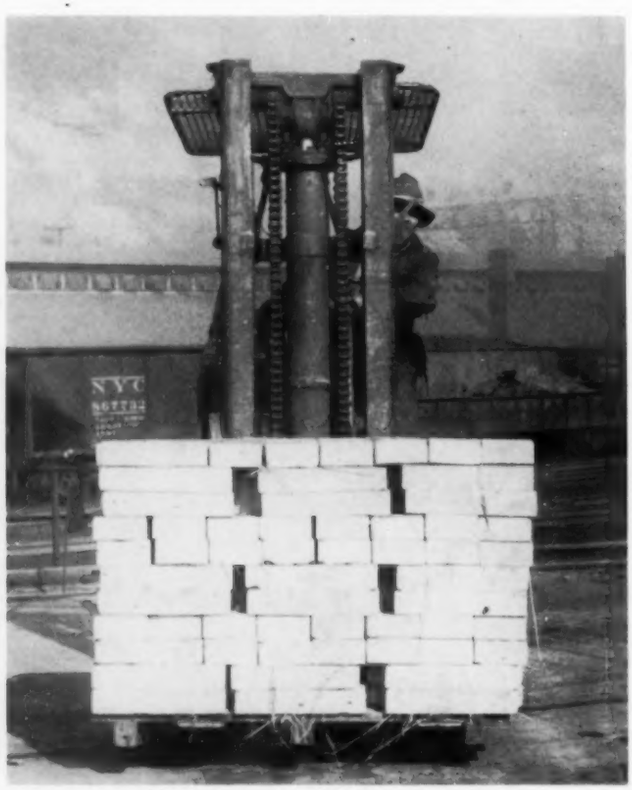


Figure 4 — Note poor visibility afforded by this unit.

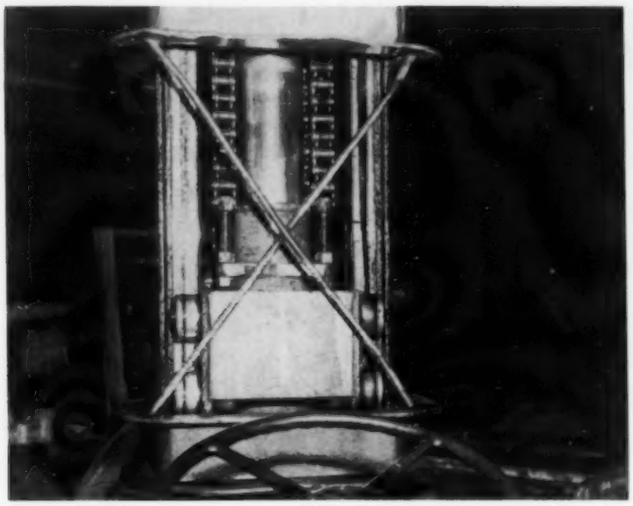


Figure 5 — View from operator's position illustrates obstruction around which he must see.

Figure 6 — Unit shown is a 10,000-lb combination ram and fork gasoline powered truck used in merchant mill warehouse.

This paper thereby becomes, in effect, a progress report to the steel industry. It calls attention to a problem in safe operation which, because of the increased use of tractors, can affect virtually every department in a steel mill. It warns that a satisfactory solution to many problems must be found if the industry is to continue the present widespread use of this flexible type of equipment. It calls attention to certain hazards inherent with current tractor designs, and outlines a general program for gradual improvement.

It should be noted that, while this particular program has been instigated by the steel industry, any resulting improvements in safe operation will accrue to all users of industrial tractors. Although steel mills are virtually the sole users of the giant ram tractors, with capacities from 30,000 to 80,000 lb, the bulk of our tractors are comparable in capacity with those used by industry in general. Thus, this program merits the attention and support of all users.

It is recognized, of course, that tractor design is by no means the sole cause of accidents. Any program for safe tractor operation must also emphasize proper training of operators, suitable maintenance of equipment, capable supervision of personnel, and good plant housekeeping. All of these will receive proper consideration in the overall program. However, the primary concern of this paper is the subject of tractor design.

Steel mills generally employ four basic types of materials handling equipment: cars, cranes, conveyors and tractors. Of the four, only tractors are free to travel in any direction at the discretion of the operator. Cranes and cars are restricted by runways and tracks, and workers usually are alert in areas serviced by these facilities. Conveyors also are confined to a definite location, and injuries can occur only when a worker is in that area; the conveyor can never come around a blind corner and strike an employee who is standing still. Thus, the flexibility of the tractor, its ability to travel to all parts of a mill, becomes a liability as well as a prime asset.

It follows, then, that safe tractor operation involves the ability of the unit to move through a mill without running into persons or equipment, without spilling its load, and without upsetting itself.

In designing a tractor for safe operation, it is believed that there are eight essential requirements:

1. It must be designed structurally to pick up and carry its rated load without failure in its frame, hoisting mechanism or drive unit.
2. It must have a high degree of stability under all loading and operating conditions.
3. It should have controls and brakes which will give positive starts and stops with minimum chance of electrical or mechanical failure.
4. It should have alternate safety devices which may be employed automatically or manually, with a minimum of delay, to compensate for any failure in the controls or brakes.
5. It should be free from noxious fumes and, if used in certain areas, should confine arcing and sparks.
6. There must be adequate protection for both the operator and adjacent personnel from falling loads and from any moving parts in the tractor mechan-

Figure 7 — The load also often blocks vision.

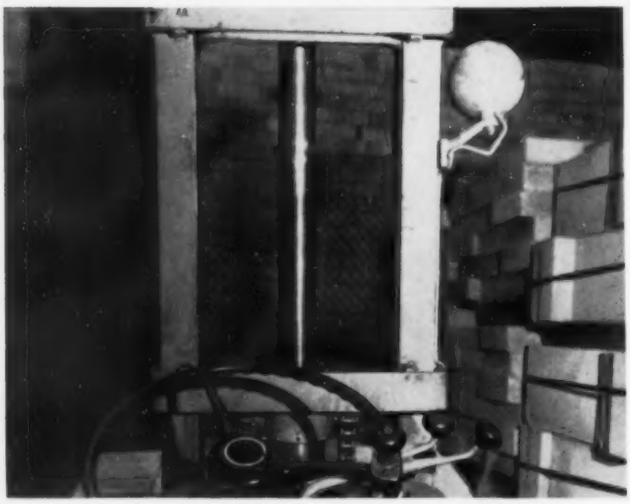


Figure 8 — Better visibility has been designed into this unit.

ism. The operator must also be protected from any object with which the tractor might collide.

7. Controls and frame must be so arranged that the operator may leave his position quickly in case of an emergency.
8. The operator must have optimum visibility at all clearance points, with and without a load.

There is no doubt but what tractor manufacturers are well aware of these requirements for safe operation. In many cases, their products are highly regarded on most counts, but it is also true that some current models leave something to be desired. It is conceded that user demand may pose problems of design which are difficult to solve. However, if demands for capacity, size or flexibility are permitted to take precedence over safety requirements, both the user and the manufacturer have been negligent.

A survey of tractors currently in use in the principal steel companies has disclosed the need for better visibility from the operator's position. In some models, particularly those in the lighter capacities, the operator's view of the area ahead of the tractor is seriously impeded by the tractor frame and hoisting mechanism, and by the load itself. Ironically, some of the worst obstacles to vision are the guards intended to protect the operator, although it must be admitted that many of these have been attached by the user subsequent to purchase, and are not a part of the basic tractor design.

Appreciation of this matter of visibility can be had from the following pictures of typical tractors:

Figure 1 shows a tractor which is widely used around open hearths. Looking closely, you may be able to see the operator peeking out from the left of the forward mast. It is questionable how much he can see of the area directly ahead of the tractor.

By contrast, Figure 2 is the same model tractor with a different model bucket hoist mechanism. Here, visibility is nearly perfect.

Figure 3 is another typical tractor in outdoor use. It will be noted that the channels, hydraulic cylinder and chains force the operator to lean over the side for forward vision.

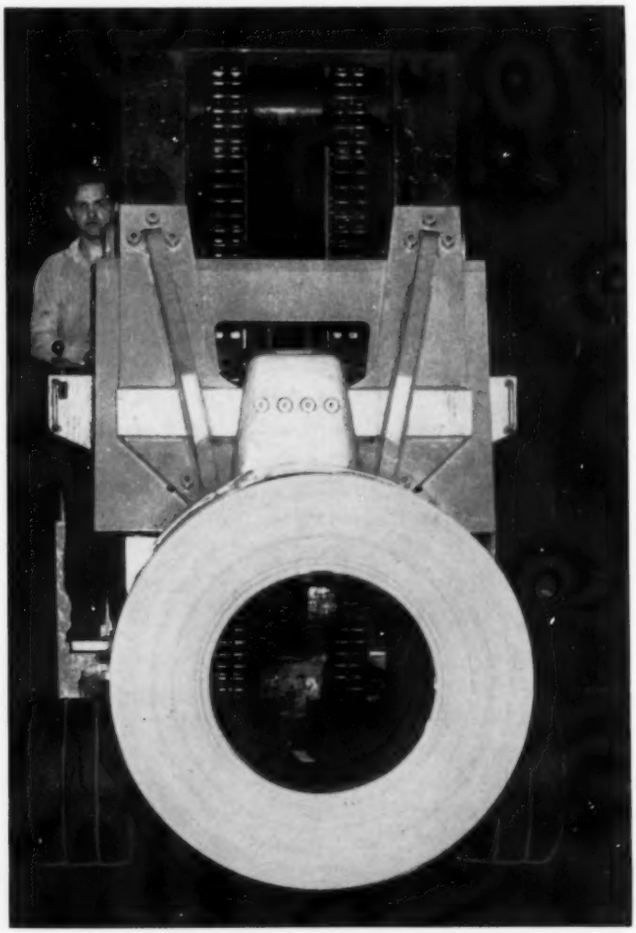


Figure 10 — On this model the operator can only see straight ahead.

Figure 4 illustrates how a headlight and the supports for a protective canopy further impede forward vision.

Figure 5 was taken from the operator's position and illustrates the obstruction around which he must see.

Figure 6 again illustrates how the hoist mechanism and other units impede the operator's vision.

Figure 7 shows how forward visibility can be impeded by both the hoist unit and a high load. Such a load might best be transported with the tractor running in reverse, but a sitdown unit does not lend itself to backward travel for any distance.

Figure 9 — Moving the center hydraulic cylinder, replacing it by two smaller cylinders in the corners, helps the operator see obstructions.

Figure 8 illustrates a recent development in design which improves visibility. When the forks are in the normal carrying position, only a small diameter piston blocks the view between the uprights.

Figure 9 shows another improvement in design which aids operator visibility. This manufacturer has replaced a large hydraulic cylinder with two smaller cylinders which are nested in the channel uprights.

Figure 10 illustrates a ram tractor with a coil in carrying position. Note how the operator — who is standing at the extreme edge of his platform — can see only straight ahead. From this position, his view diagonally to his left is obstructed by the channel, chain and carriage.

Figure 11 shows the same tractor with the operator peeking through a narrow opening for a view of the far side of his tractor.

Figure 12 shows by contrast, a later model tractor from another manufacturer which affords improved visibility. With the operator standing in the middle of widely spaced uprights, his vision ahead and to either side is excellent.

Figure 13 is another type of tractor which is found in sheet and tin mills. In this case, forward visibility is very good.

Already U. S. Steel has taken positive action with respect to the procurement of new tractors. Pending further developments in this program, all specifications sent to prospective suppliers of new tractors contain the following paragraph:

"Consideration will be given only to tractors which provide the operator with maximum visibility of load and all clearance points during both forward and reverse movement of tractor. The bidder is requested to furnish with his quotation, drawings or photographs which illustrate the visibility of the equipment being offered."

In addition to the problem of visibility, other factors are known to have contributed to accidents involving tractors. Among these are improper securing of loads, inadequate brakes, faulty controls, absence of normal safeguards, and improper steering.

It is admitted that tractor engineers are faced with a difficult problem. They must build into each unit the structural strength necessary to handle prescribed loads — and often overloads — and to withstand the use and abuse of many years of service. Dimensions for length and width must be compressed for minimum aisle requirements and for maximum maneuverability. The overall height must be low enough to clear doors and other overhead obstructions, yet many fork and ram tractors must be capable of tiering loads to considerable heights.

As a result, the tractor designer must squeeze into the smallest possible cube, the necessary controls, drive unit, hoist and steering assemblies, pumps, motors, source of power, miscellaneous component parts, and a substantial amount of structural steel. Frequently, clearances are measured by the half-inch, and there is little or no room for desirable safeguards. When the tractor width has been trimmed to meet aisle requirements, an adequate hoisting mechanism may have very limited openings for vision ahead. If the tractor is equipped with attachments such as rotating devices, side-loaders, clamps or side-shifters, visibility can decrease to the point where the operator could make good use of radar for forward progress.

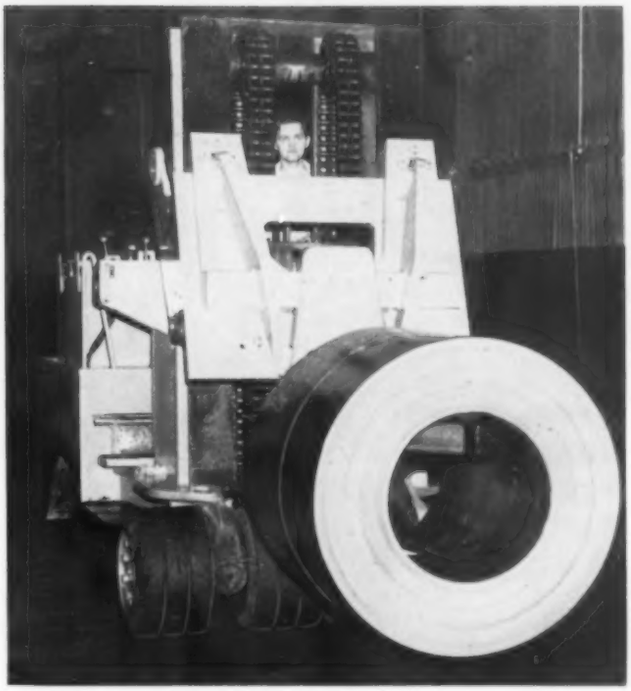
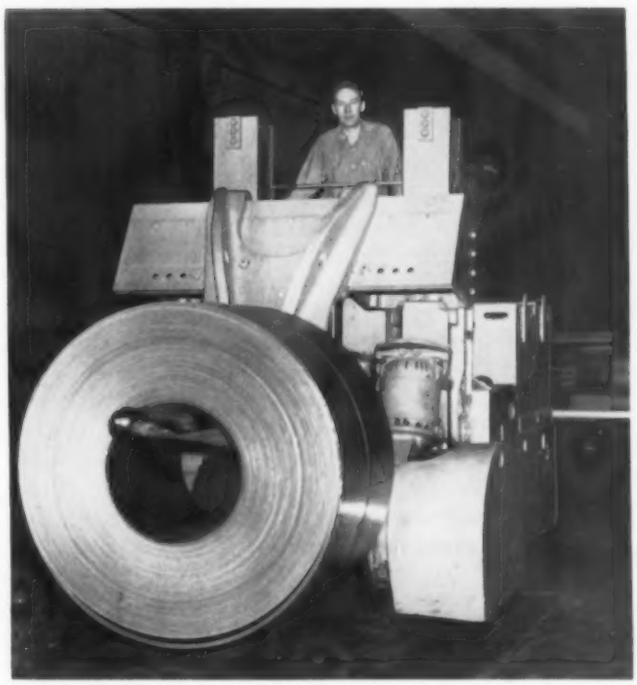


Figure 11 — This is the same tractor as in Figure 10 with the operator in a different position.

Most tractor manufacturers agree that the requirements of some user, or group of users, have been responsible for virtually every evolution in design. It follows that a concerted demand for improved safety characteristics ultimately will bring the desired results. Upon this premise is based the current phase of this program.

It must be noted that this is by no means the first attempt to improve tractor design from the safety view-

Figure 12 — Excellent vision is given by this unit.



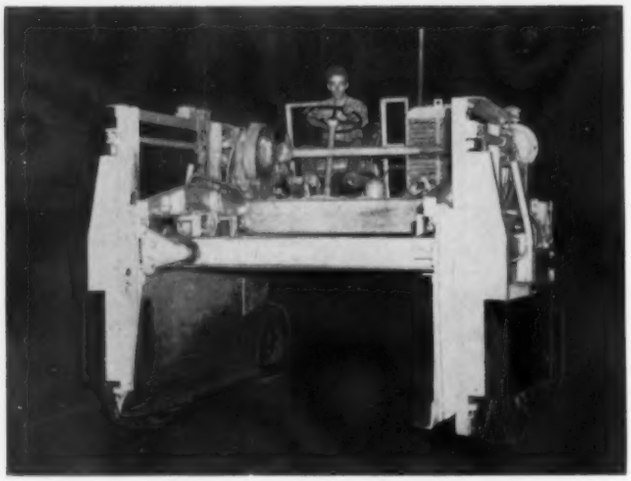


Figure 13 — The straddle type unit affords excellent visibility.

point. Engineers of the tractor manufacturers, meeting as a committee for their trade association, have done much to develop many improvements for safe operation. Other groups, representing technical societies, specific industries and the Armed Forces have developed codes and specifications for guidance when new equipment is purchased. Much credit is due these groups for all that has been accomplished so far, and it is likely that each group will agree that there is still more to be done.

Obviously a program of this nature cannot be rushed, and certainly it is not expected that it can be completed by any specified date. It is planned to work closely with manufacturers, other users, and interested technical and trade societies. Apparent hazards in visibility, brakes, controls and guards will be explored carefully, and every effort will be made to develop satisfactory designs for safe operation. It is probable that many of the ultimate designs will combine the best thinking of all tractor manufacturers.

Preliminary discussions already have taken place with five large tractor manufacturers, and others will follow in due course. In each case, top management and engineering personnel have indicated their realization of the seriousness of the problem. While we are concerned primarily with the safe operation of tractors in the steel industry, the manufacturers are well aware that this matter affects the use of tractors in every type of business. Without exception, assurances have been given that, in the months to come, the design of safety characteristics will receive the closest possible attention.

As this program develops and solutions are found for existing hazards in tractor design, it is planned to prepare specifications which will assist in the proper selection of new equipment. However, safe design should not and cannot be limited to future purchases. The steel industry currently employs several thousand tractors in various operations, and many of these offer obstacles to safe operation. It would be neither practical nor possible to make wholesale replacements of every such unit, but in many cases relatively simple alterations can eliminate existing undesirable hazards. This phase of the safety program must receive close attention in every mill.

In conclusion, it should be emphasized that both the user and the manufacturer must assume that the safety viewpoint shall be a primary factor in suggesting and selecting a tractor for a given operation. Since the slogan of the steel industry is "Safety First," no method of materials handling can be justified unless it at least matches the safety performance obtained from other types of handling equipment.

DISCUSSION

PRESENTED BY

B. I. ULINSKI, Director of Engineering, Automatic Transportation Co., Chicago, Ill.

B. I. Ulinski: As director of engineering of the Automatic Transportation Co., I will attempt to speak for the tractor industry in general. I feel that most of us present here know how the various improvements made in industrial tractors since 1935 have contributed in a large way to the success of steel mill operations, making it possible and practical to roll steel at today's mile-a-minute pace. In making these tractor improvements along with tremendous increases in rated-load capacities of the various tractors, manufacturers kept in mind the importance of the design requirements listed by Mr. Lord.

After listening to Mr. Lord, I feel I am safe in making the following comments.

On design requirement number one which reads as follows: "It must be designed structurally to pick up and carry the rated load without failure of the frame, loading mechanism, or drive unit." Structurally, most modern tractors have more than sufficient strength to handle rated loads without failure of any of the tractor components. If failures do occur, they usually can be traced to continuous overloading or abuse such as running into overhead or ground obstructions caused by carelessness by the tractor operator. Since tractors are extremely heavy, the impact of running into such obstructions or a concrete curb can be extremely destructive to tires, wheels, and various units as well as the framework.

Number two design requirement reads: "It must have a high degree of stability under all loading and operating conditions." Generally tractors are sufficiently counterweighted to allow safe handling of rated loads, but here again the handling of overloads reduces the safety factor sometimes to the zero point. Adding more counterweight to the tractor obviously does not solve the problem because if that was done the tractor operator would only handle heavier loads. To prevent unauthorized overloading two safety devices are required.

One is a properly set and sealed overload relief valve in a hydraulic life mechanism, or a circuit breaker if the lift is of the electrical-mechanical type. The installation of either of these devices will limit the weight of the load that the tractor will lift. The second safety device is required for prevention of picking up too long a load in regards to its weight which would upset the tractor by exceeding the safe in. lb moment for which the tractor is counterweighted. For electrically-powered tractors this is simply accomplished by insertion of a

spring loaded switch under the trail axle which would snap off the power to the motor should the tractor try to pick up a load length beyond the safe counterweight point. In place of the switch, a mechanical device of some sort could be installed on gas-powered trucks to disconnect the clutch, although I do not know if such devices are available for industrial tractor use today.

Number three design requirement reads: "It should have controls and brakes which will give positive starts and stops with a minimum chance of electrical or mechanical failure." Generally controls furnished on the various makes of tractors are adequate when new. However, misadjustment or abuse of the mechanism sometimes creates a situation that is a distinct hazard to safe operation. I feel, therefore, that a lot can still be done by tractor manufacturers, to develop sturdier, simpler controls of a standardized nature that would reduce the profusion of designs now existing in various makes of tractors and would make servicing a much more simple chore.

Number four design requirement reads as follows: "It should have an alternate safety device which may be employed automatically or manually with a minimum of delay to compensate for any failure to controls or brakes." It is obvious that the control levers and brake pedals should be so constructed that should any vital point in the control linkage system fail, the truck will stop automatically. Also the trucks electrical circuit should have control contactors wired so that the current can be opened by reversing the directional switch. This will prevent flowing of power to motor in case of welding of a contactor. I believe that most of the various tractors offered on the market today have some combination of these safety features.

Number five is a design requirement which reads as follows: "It should be free from noxious fumes, and if it is to be used in certain hazardous areas should confine arcing and sparks." Electric trucks today can be furnished with spark enclosed controls that are fairly safe to operators in hazardous areas. Gasoline-powered trucks can be supplied with special mufflers that will quench sparks, or with catalytic exhaust system that will absorb the dangerous carbon monoxide gas. Obnoxious smells, however, cannot be constantly eliminated from gas truck exhausts.

Number six design requirement reads as follows: "There must be adequate protection for both the operator and adjacent personnel from falling loads and also from any moving part of the tractor mechanism. The operator must also be protected from any object with which the tractor might collide." A center control truck when equipped with an overhead canopy is one of the safest for the driver to operate since it offers him protection to a great degree from all sides. A rear-end control tractor should have a substantial steel guard built around the operator's platform. These guards are not standardized by tractor builders because the various users have special designs of their own to conform with the safety regulations which they live by, and which design they usually request be furnished when tractor equipment is being purchased.

The number seven design requirement reads: "Controls and the frame must be so arranged that the operator may leave his position quickly in case of necessity." In general the center control tractors have both sides open and fairly free from obstructions so that in case of necessity the operator can readily jump to safety. The rear-end tractors are, as a rule, easier to dismount, providing the steel guards are properly designed so that they are not too cumbersome to clear.

The number eight design requirement reads: "The operator must have optimum visibility for all clearances with and without a load." Visibility is a very important factor for safe tractor operation. I feel confident that most tractor manufacturers are aware of this requirement. Continuous efforts are made to clear up structural interferences before the operator's eyes. In the present day hydraulic lift tractors there are a certain number of heavy structural parts eliminated that were used with straight chain lift trucks. The upright structures are also simplified, and narrowed down in cross section. Other mechanism is kept to a minimum size so that the obstruction to the operator's vision will be as little as possible.

Our own company resorts to high pressure hydraulics which decreases the diameter of the hydraulic cylinders and further decreases vision interference. Unfortunately, the shape or the bulk of the load to be carried on the tractor definitely determines the limit of forward vision for the operator, and on heavy 30,000 to 80,000-lb loads, the operator's platform position will have to be high enough above load in order to enable him to see clearly. Usually dual controls are so positioned on the large tractors that it is possible for the operator to reach them from any area across the width of the tractor. It must, however, be remembered that nothing is perfect and improvements can and are being made constantly.

I feel that Mr. Lord's challenge to the tractor industry will be taken seriously, and that consequently much good will result from his presentation.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

EMERGENCY DRIVE ARRANGEMENTS *for* BLOOMING MILL AUXILIARIES

By F. C. FENNELL
Steel Mill Engineer
Industry Engineering Dept.
Westinghouse Electric Corp.
E. Pittsburgh, Pa.

. . . . the selection of the best emergency system for a mill requires careful study to obtain the most economical overall unit . . . .

▲ DUE to its importance as the initial rolling operation in the steel plant, considerable emphasis is placed on insuring the continued operation of the blooming mill to prevent any interruption of the flow of steel to the rolling mills and processing lines which follow. Although the probability of failure of electrical equipment is no greater in the blooming mill than in other steel plant operations, any loss of time due to an outage is much more severe since the cost per hour of down time is usually greater. In both main and auxiliary electric drives, the problem of keeping the blooming mill in operation in spite of equipment failure receives much attention both from the electrical manufacturer and the steel plant operator. This discussion deals only with auxiliary drives of the blooming mill and in particular with the variable voltage auxiliaries which bear the major effort of mill production.

Certain of the auxiliaries such as the tables, feed rolls, screwdowns, and manipulators handle the steel about 70 per cent of the total rolling time. During the rolling of an ingot these drives may each operate from ten to thirty times and they are therefore naturally more subject to failure than other drives which may operate only once for each ingot rolled. It is now a well established practice to provide these particular auxiliaries with individual generator variable voltage drives. The improved performance of the variable voltage system has been recorded in numerous papers presented before the AISE. Because these units are so important to mill production it is common practice to provide some means of transferring to an emergency power source in case of failure of a generator or its associated control. The number of variations of emergency arrangements is practically unlimited, but the majority of installations fall into several main categories including (a) emergency operation from one of the drive generators; (b) provision of a standby generator and controller; and (c) duplication of generators. A comparison of these three main classes of emergency arrangements is presented from the standpoint of initial equipment cost, installation cost, floor space requirements, maintenance, and performance under both normal and emergency operating conditions.

THE BASIC SYSTEM

As a basis for comparison, a typical high performance reversing blooming mill similar to the one shown in Figure 1 has been selected. For the purposes of this discussion, the typical mill has pairs of 150-hp mill motors driving the delivery table and the screwdowns

Figure 1 — A typical high performance reversing blooming mill shows 150-hp auxiliary drive motors on the delivery table and screwdowns.

as shown in the illustration. Similar pairs of 150-hp motors drive the entry table, left manipulator and right manipulator. The two feed rollers on each side of the mill are driven by 50-hp mill motors.

A schematic arrangement of the mechanical and electrical auxiliary equipment on this typical mill is shown in Figure 2. Two duplicate motor-generator sets are shown and each of the units with the exception of the screwdown is supplied with power from one generator. The two motors making up a table or manipulator drive are mechanically connected and operated electrically in series. In order to provide a high running speed, the screwdown is usually arranged with a generator for each of the driving motors as indicated by generators No. 4 and No. 5. Excitation for the motors and generators usually comes from a separate exciter set not shown in the illustration.

This arrangement provides the minimum of equipment necessary for normal operation of the blooming mill. It represents the minimum initial cost, minimum floor space requirements and minimum maintenance and for this reason is used as a basis for comparison. It will be noted that there is no means of switching or transferring drives in case of failure of one of the generators or its control.

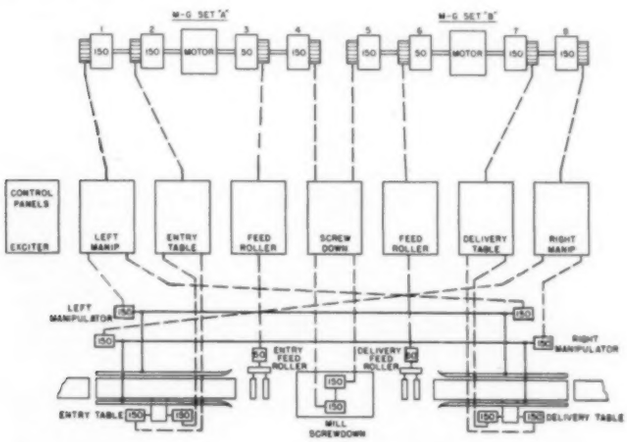


Figure 2 — Schematic arrangement of mechanical and electrical equipment for blooming mill auxiliaries with no provision for emergency operation.

The circuit shown in Figure 3 is typical of the basic scheme of control used in all blooming mill auxiliary variable voltage drives. Neglecting the effect of current limit field CLF the rotating regulator acts essentially as a voltage regulator with a stable operating condition obtained when voltage field VF balances pattern field PF. If only these rotating regulator fields were used, the rate of generator voltage rise would be so rapid after closing forward contacts F or reverse contacts R that the load accelerating current might rise to unsafe values. Current limit field CLF is included to prevent this condition. Neglecting resistor R2 for the moment, current flowing in the armature circuit of the generator produces a voltage drop across series resistor R1. This voltage is impressed on current limit field CLF but is opposed by a bias voltage which appears across resistor R3. The bias voltage is normally provided by a full wave selenium rectifier indicated at A which converts the a-c output of a small transformer to the low d-c voltage required. Current flows in the current limit field

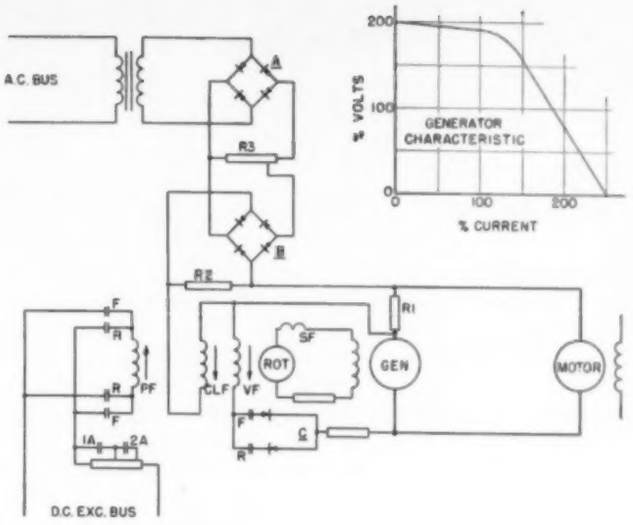


Figure 3 — Basic scheme of control for variable voltage auxiliary drives.

only when the voltage drop across resistor R1 produced by load current exceeds the bias voltage at R3. Since, as shown by the direction of the arrows, current limit field CLF opposes pattern field PF, the effect of high load currents is to reduce generator voltage when the drive is running or to limit the rate of acceleration when the drive is starting or stopping.

The rectifier indicated at B is arranged so that voltage produced by load current always opposes bias voltage whether the drive is motoring or regenerating. A leak resistor R2 is included in the bias circuit so that a small current proportional to load current can flow in the current limit field below the bias cut-off point. This gives the system a light droop at rated loads and a heavy droop at loads greater than normal as shown in the curve of the illustration. For most drives the control is arranged to limit maximum current to about 250 per cent of full load. Thus, the rotating regulator provides forcing of generator voltage to obtain maximum rate of acceleration and deceleration and yet keep the current within safe commutating limits of the machines.

Rectifiers at C and the associated directional contactors are used on certain drives having relatively high accelerating torque requirements to insure that the polarity of the voltage field is correct during plug reversals. A circuit not shown in this simplified illustration prevents opening of the voltage field when neither of the directional contacts are closed. Contactors 1A and 2A provide several speed control points below top speed of the drive.

EMERGENCY OPERATION FROM STANDBY GENERATOR

Perhaps the most obvious means of providing some form of emergency operation is by adding a spare or standby generator which can be started up and connected to replace any one of the other generators. Such a system is shown schematically in Figure 4. A complete standby motor-generator set including a standby exciter shown in the illustration as m-g set "C" is

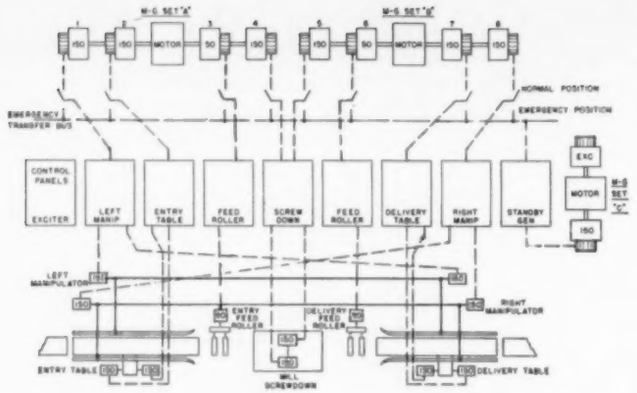


Figure 4 — Schematic arrangement of mill auxiliaries shows addition of a standby generator and transfer bus for emergency operation.

usually provided and the unit remains idle until needed. In addition to the standby generator and exciter, a controller for the generator, a standby rotating regulator, an emergency transfer bus, and transfer switches have been added to the basic scheme shown in Figure 2.

In an installation of this type it is customary to make the standby generator equal in capacity to the largest normal generator. By means of tuning resistors in the fields of the standby rotating regulator the characteristics of the standby generator are automatically changed to suit the rated current and voltage of each of the normal generators. A typical installation of this type now in operation is equipped with a 150-kw standby generator which in an emergency is used to provide power to drives rated 150-hp, 230-v, 75-hp, 230-v and 10-hp, 50-v.

For normal conditions the blooming mill with this arrangement of units operates exactly the same as in the basic scheme which has no emergency arrangement. It provides in an emergency one outstanding advantage over other emergency schemes — for loss of a single main generator the standby unit can be placed in service and the affected drive can be operated at full speed just as though no failure had occurred. Since only a single standby unit and transfer bus is indicated this system can protect the mill against loss of only a single generator or controller.

Figure 4 illustrates only the main circuit switching necessary to change over from normal to emergency operation. Unless a standby master switch and standby limit switch are added for each drive a certain amount of control circuit switching is also necessary. To provide maximum emergency coverage of control devices, control circuit switching should be schematically located in the circuit as close as possible to the master switch and limit switch in a manner similar to that shown in Figure 5. The number of control circuits that must be transferred depends on the actual master switch and limit switch used.

To provide complete coverage for all control apparatus requires a number of additional transfer circuits for such devices as overload relays, field loss relays, etc. Since they operate relatively infrequently it is the usual practice not to transfer these devices in order to keep the normal operating circuits as simple as possible. As a general rule it is best to avoid systems in which equipment or circuits required only for emergency use tend to jeopardize normal operation of the mill by making the normal system more subject to failure, or by so complicating the normal system that mill electricians are handicapped in trouble shooting.

Figure 6 is a shop photograph of a blooming mill variable voltage control board for a standby generator system in which the type of control circuit switching just described was used. The multipole control relays at the top of the panels automatically transfer control circuits when the main power switch is thrown from normal to emergency position. This figure also shows how the control panels are designed so that contactors requiring only regular maintenance are located at the

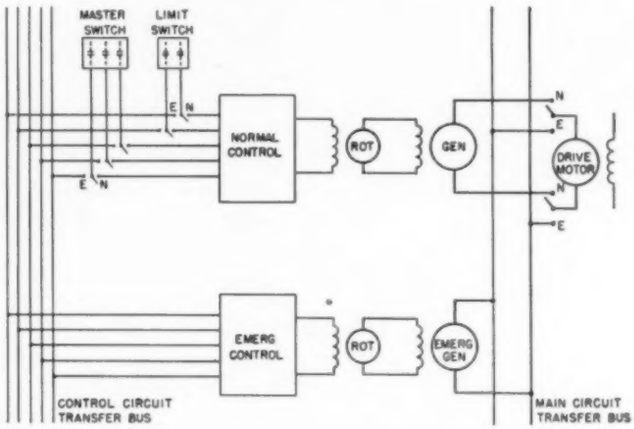


Figure 5 — Standby generator control scheme illustrates switching of both control and main circuits.

top, while meters and relays used in tuning and adjustment are located so as to be readily accessible to the mill electrician.

One of the main advantages of the standby generator system as previously stated is that for an outage on one normal generator the mill can operate just as though no failure had occurred. Usually mill electricians adjust the operating voltage of each generator to suit the maximum speed desired by the operating crew. Since each drive usually therefore has a different top voltage it becomes apparent that the standby generator must be recalibrated not only for each generator rating it replaces but also for the particular operating condition of each drive. Recalibration to suit the normal generator rating is done automatically, but for simplicity it is desirable that recalibration to suit the operating condition be done manually by the electrician each time the standby unit is put into service. To arrange for automatic recalibration of this type causes considerable complication of the control transfer circuits.

On a mill to be installed soon in the Pittsburgh area the automatic recalibration feature has been provided and a simple control transfer circuit obtained by switching control at the fields of the rotating regulator rather than at the master switch. By this means the tuning resistors and control for the normal circuit are also used on the emergency circuit and precise recalibration is automatically obtained. It is of course apparent that this method of control switching does not provide for failure of any devices on the control panel since the contactors and resistors as well as the master switch are in the circuit ahead of the transfer devices. On this

particular installation it was believed that this loss of coverage was more than offset by the simplicity of the control transfer circuit which gave the automatic recalibration desired.

EMERGENCY OPERATION FROM SCREWDOWN GENERATOR

In the basic arrangement shown in Figure 2 the only drive provided with two generators for two motors was the screwdown. It seems natural therefore to consider taking one of the screwdown generators and using it to supply power during emergencies in a manner similar to that used in the standby generator scheme. A schematic arrangement of this type of system is shown in Figure 7. Actually this scheme of control is very similar to the standby generator system and merely amounts to giving the standby unit a full time job rather than letting it stand idle. This arrangement is naturally somewhat more economical in price and floor space than the standby generator scheme since there is one less generator, rotating regulator, and controller required for the installation. However, it has one distinct disadvantage. During emergencies the two screwdown motors are reconnected to operate in series from the one remaining generator and this cuts the maximum speed of the screws in half. The production of the mill is not necessarily cut in half under this condition, but there usually will be some reduction in output. For short movements of the screw, the loss in speed will hardly be noticed since the motors do not operate long

Figure 6 — Variable voltage controller for standby generator emergency arrangement. Note placement of control devices for ease in maintenance and adjustment.

enough to get up the speed, but for long movements such as opening up for edging passes on high lift mills an appreciable loss in time will result.

In this system as in the standby generator arrangement, if automatic recalibration of the emergency generator to suit the actual operating requirements of each drive is required, an advantage in simplicity of control circuit switching can sometimes be gained at the expense of loss of emergency coverage by transferring control at the fields of the rotating regulator rather than at the master switch.

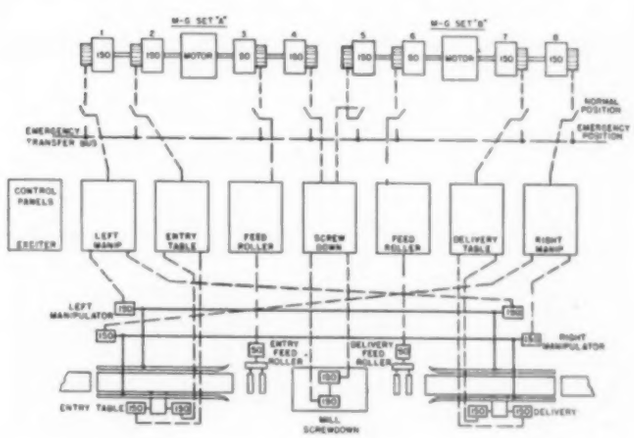
EMERGENCY OPERATION FROM DUPLICATE GENERATOR

The ultimate in emergency transfer arrangements is to provide duplicate generators for every drive on the mill. Usually this is impractical both from the standpoint of cost and space requirements, but a modification of this scheme has found considerable favor throughout the industry. A typical arrangement of equipment is shown in Figure 8. Each drive normally operated with two motors mechanically connected together is provided with two generators and for failure of one of the generators the two motors are transferred to the remaining generator and operated in series from it. Since this is the normal operating condition of table and manipulator drives in the basic scheme, no reduction in rated drive speed results. However, if advantage is taken of having two generators and the drive is normally operated faster than rated speed, a reduction in actual operating speed will be noticed when the emergency connection is used. The screwdown top operating speed will be cut in half if trouble occurs on the screws since two generators were required even on the basic system.

The feed roll which has only one generator is transferred to the corresponding main table generator and operated in parallel with the table motors. Since the feed roll motor is small in comparison with the table drive, the generator can handle the extra capacity without much loss in performance although a certain amount of sluggishness may be noticed. The question naturally arises as to whether it might be possible to damage the feed roll motor during emergency operation by stalling it with the generator current limit point set corresponding to the rating of the larger table motors. Protection against this condition is obtained by the addition of a separate bias circuit to the current limit field of the table rotating regulator so that excessive current in either the feed roll or the table motor will limit generator voltage.

While this emergency arrangement requires the maximum amount of equipment and is slightly more expensive than the other systems it has several advantages. First, it is apparent from the illustration that the mill can remain in operation with a number of gener-

Figure 7 — Schematic arrangement shows use of screwdown generator for emergency operation.



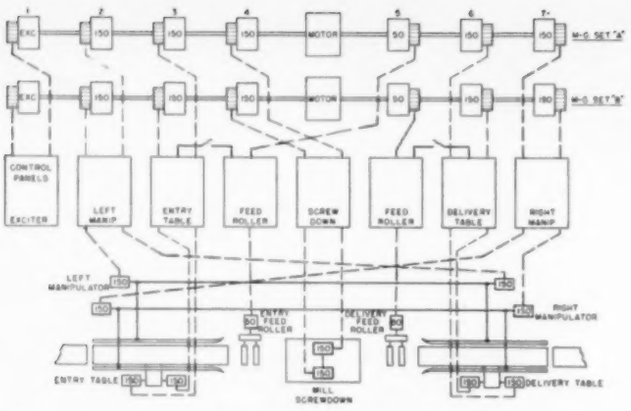


Figure 8 — Schematic arrangement shows emergency operation from duplicate drive generators.

ators or controllers out of service. In fact, operation is still possible with one motor-generator set stopped. Second, each generator is provided with its own set of control devices so that maximum emergency coverage is obtained without the elaborate control transfer switching required for the other systems. Third, two motor drives can be operated in emergencies from only one motor without requiring the addition of any extra main circuit switches. Fourth, table and manipulator drives can be operated at higher speed than in the basic system.

An arrangement of variable voltage auxiliary equipment in the motor room of a mill having this type of emergency system is shown in Figure 9. This is the motor room of the high performance blooming mill shown in Figure 1. The control panelboard is in the background, rotating regulator sets are in the foreground, and the variable voltage motor-generator sets are in the center of the illustration.

SYSTEM COMPARISON

As a guide by which the various systems can be compared several tabulations have been compiled. Relative initial costs of the electrical equipment are shown in Table I in which all units are in per cent of the total initial cost of the basic system which has no emergency operating arrangement. In Column C the cost of the standby motor-generator set has been added under the item for main sets. It is assumed that a complete standby set separate from the normal exciter set is used so that the standby unit can remain idle until needed. Since the induction driving motor of the standby set will have a rating in the neighborhood of 300 hp, a switchgear unit for starting the motor has been added. Switchgear costs are based on 2300-v metalclad units for steel mill service. Motor-generator set costs are for open self-ventilated machines. D-c control costs are based on the open factory assembled structures commonly used throughout the steel industry. It will be noted that since motors and brakes make up about one-third of the total, large variations in the cost of motor-generator sets and control have a relatively minor effect on the total initial cost.

Figure 9 — Arrangement of variable voltage auxiliaries in the motor room of the mill shown in Figure 1.

Table II indicates the relative cost of installed conduit and cable for the various systems. This table is based on a hypothetical installation in which the total installation cost of the basic system in Column A is divided 30 per cent inside the motor room and 70 per cent outside the motor room. This division is fairly representative of an average mill, but it should be recognized that although the cost of installing similar equipment inside the motor room is reasonably constant for most installations, there may be large variations in overall installed cost due to differences in the relative location of motor room and mill. It will be noted that the tabulation shows no change between systems in installation cost outside the motor room. This is in keeping with the general practice of running leads for each motor back to the motor room and making the series connection at the panelboard if required.

Floor space requirements for the various systems are shown in Table III. This tabulation represents only space actually required for equipment and does not include factors to cover aisle or work space.

Table IV provides an indication of the relative maintenance requirements of the systems. The item for total brushes represents only machines inside the motor room. In Column B the items for contactors and for total contacts indicate the increase in these units required over the basic scheme to provide the emergency transfer feature. This is based on the type of installation shown in Figure 6 where transferring of control circuits is done automatically by transfer relays when the main power circuits are switched manually. For installations where manual control circuit switching is acceptable the number of contactors and relays required can be reduced, although the total number of contacts will not be appreciably affected. The item for total contacts includes relay, contactor, knife switch, and interlock contacts for power and control circuits. No attempt has been made to indicate total relative maintenance of the systems as this falls more in the province of the user than the manufacturer. This relation can be established by applying to each item a factor indicative of the usual maintenance time required.

VARIATIONS

As previously mentioned there is an almost unlimited variety of emergency transfer arrangements which can be developed although most tend to be modifications or combinations of the three basic arrangements

TABLE I

Comparison of Initial Equipment Costs

	No emergency arrangement	Emergency Operation From		
		Screwdown generator	Standby generator	Duplicate generator
	A	B	C	D
D-c control and rotating regulator	21.2	23.2	25.9	33.6
A-c control	0.4	0.4	0.4	0.3
Main m-g sets	37.8	37.8	44.3	46.5
Exciter m-g set	1.5	1.5	1.5	0
Switchgear	6.4	6.4	9.2	6.4
D-c motors and brakes	32.7	32.7	32.7	32.7
Total initial cost	100.0	102.0	114.0	119.5

TABLE II

Installation Cost — Conduit and Cable

	No emergency arrangement	Emergency Operation From		
		Screwdown generator	Standby generator	Duplicate generator
	A	B	C	D
Installation inside motor room	30*	30	33	42
Installation outside motor room	70*	70	70	70
Total installation	100	100	103	112

*Note — Proportional cost inside and outside the motor room may vary widely depending on mill layout.

TABLE III

Floor Space Requirements in Square Feet

	No emergency arrangement	Emergency Operation From		
		Screwdown generator	Standby generator	Duplicate generator
	A	B	C	D
D-c control board	106	129	140	192
A-c control board	5.6	5.6	5.6	5.6
Main m-g sets	213	213	272	370
Exciter and rotating regulator m-g sets	66	66	74	67
Switchgear	62.5	62.5	78	62.5
Total floor space	453.1	476.1	569.6	697.1
Per cent space required	100	105	125	154

TABLE IV

Comparison of Maintenance Requirements

	No emergency arrangement	Emergency Operation From		
		Screwdown generator	Standby generator	Duplicate generator
	A	B	C	D
Generators	8	8	9	12
Exciters and rotating regulators	9	9	11	14
A-c motors over 200 hp	2	2	3	2
A-c motors under 200 hp	3	3	4	3
Total brushes, per cent	100	100	117	154
Contactors and relays, per cent	100	128	142	179
Total contacts, per cent	100	177	195	165

already described. It is becoming more and more common to provide variable voltage drives for the manipulator finger lifts on blooming mills. Where this type of drive is used, the opportunity exists for using the finger generator as the emergency unit in a manner similar to that already described for the screwdown. On installations which have fingers on both entry and delivery sides, the mill can operate in emergencies with only the front finger in service while the rear finger generator supplies the emergency bus. For mills having only one finger available, an economical solution is to transfer the finger motor to a standby constant potential d-c panel for emergency operation and to use the finger generator as the emergency unit. Making use of the variable voltage finger generator in this manner eliminates the weakness of the screwdown generator emergency system — that of crippling the mill in emergencies by operating the screws at half speed.

It has been found desirable on a few mills to provide several emergency buses and to thereby make provision for failure of more than one unit. Generally systems of this type tend to become over complicated and require special expensive transfer devices to simplify the electrician's problem of switching over to emergency operation.

CONSTANT POTENTIAL AUXILIARIES

Constant potential auxiliary drives in the blooming mill are usually not subject to as many repetitive operations as the variable voltage auxiliaries since they normally operate only once or twice for each ingot. However, their continued operation is just as important as that of any portion of the mill and in some cases it is desirable to provide for emergency operation of these units.

To attempt to provide in one standby controller all of the various control features such as reversing, nonreversing, plugging, or armature shunt slowdown and also all of the horsepower ratings normally encountered would lead to elaborate complicated control interlocking to insure correct operation for each particular drive. An emergency system is therefore usually limited to a standby controller for certain critical units of similar sizes and types. Control transferring takes place in a manner similar to that described for the standby generator variable voltage arrangement.

A blooming mill soon to be installed will have one standby controller in each panel group to serve only the constant potential mill table drives. Each of these tables has the same type of control and ratings are either 50 hp, 75 hp, or 100 hp. Other constant potential drives on this mill will not have any emergency transfer arrangement.

It has been the purpose of this paper to present both the advantages and limitations of several emergency drive arrangements commonly used for blooming mill auxiliaries. From a price standpoint the system using one of the normal generators was found to be most economical although this arrangement sometimes has the disadvantage of crippling the mill during emergency operation. The standby generator system was found to be about midway between the other two arrangements in price, maintenance, and floor space requirements and to have the advantage of full speed operation during emergencies. The duplicate generator system was found to be outstanding from the standpoint of performance and flexibility at the expense of higher price and larger space requirements.

The selection of the best emergency system for a particular mill requires a careful study to evaluate the increased initial cost, increased maintenance, and loss of production during emergencies against the cost of a mill shut-down.

DISCUSSION

PRESENTED BY

I. N. TULL, Electrical Superintendent, Corrigan-McKinney Works, Republic Steel Corp., Cleveland, Ohio.

T. B. MONTGOMERY, Engineer-in-Charge Control Design, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. B. SNYDER, Assistant Manager, Steel Mill Div., Industrial Engineering Divs., General Electric Co., Schenectady, N. Y.

JAMES FARRINGTON, Special Assistant to Chief Plant Engineer, Wheeling Steel Corp., Steubenville, Ohio.

H. H. ANGEL, Electrical Engineer, Construction and Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

F. C. FENNELL, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., E. Pittsburgh, Pa.

I. N. Tull: Mr. Fennell's analysis may well be applied to other types of mills as well as to the blooming mill, which one of his associates last year referred to as "the iron horse of the steel industry." While the subject matter of Mr. Fennell's paper is concerned mainly with equipment spares, we must remember that control wires and main cables sometimes fail also, and spare conduit and conductors between the control centers, motors and generators are usually advisable.

With present heavy tonnage requirements, any loss of time due to inability to continuously roll on high capacity mills is disastrous. Many mills normally roll more than two hundred tons per hour, and an hour's delay in time is not the measure of loss as such, but in the tonnage lost that can probably not be replaced.

Naturally none of us wants to spend any more money for insurance than can be justified by the facts, and the simplest arrangement of controls and the equipment involved to effect good protection, is usually the best from all viewpoints. Spare equipment as such, is valueless if not in operable condition when required on short notice. Many times, control contacts through disuse, will not function due to insulating particles of dirt or lint from rags used for cleaning, and some of these cases to my knowledge, have caused long time and embarrassing delays, as they are difficult to locate.

Even if suitable arrangements for emergency use are provided for all reasonable contingencies, if the maintenance personnel is not properly informed, trained and drilled in the functions of the equipment in their care, much valuable time and tonnage is still going to be lost. Routine, not perfunctory, maintenance is necessary for good performance.

Mr. Fennell's paper, his methods of analysis, and his tables of comparison are very enlightening and unique on this subject. I am sure that a study of any particular mill, using these methods as a guide, will materially help any of us to arrive at a sensible answer to our problem.

T. B. Montgomery: It seems obvious that the present-day demands of the steel industry by the increased drains on the National economy has forced our thinking into an evaluation of items such as given in the paper.

We might consider that time and motion study resulting in improvements in production costs and volume, rather than the working out of new and novel ideas seems to be the principal theme of the day. Production availability has suddenly grown, and is reflected in monthly output records. In reviewing Mr. Fennell's paper, I could not help but be reminded of what is being done on the railroads in the matter of continuous availability of equipment as compared to what is required of us in the steel industry.

This emphasis apparently is general throughout industry. I believe all of us are of the same mind that this paper is the result of a careful study of these mills from this point of view, the study evaluating the factors of the design components from the standpoint of continued service, and the maintenance involved from the outage record. As the author has indicated, the evaluation depends on the outages of the year, the cost of the outage, the initial cost of the equipment and the maintenance of each system. It is in maintenance that the operating personnel, perhaps to a greater extent than the manufacturer, come into the picture. I hope that from them we can accumulate more data on these particular items to guide those who have the responsibility of designing the equipment.

On a mill that is now being laid out by the company I represent, the arrangement is in accordance with Mr. Fennell's second scheme. As Mr. Fennell shows, however, there is one problem that has not been decided at the moment, that concerns which generator to use for emergency. Obviously, this question involves the factor of duplication in size, and, of course, it is also of great importance that the characteristics of the generator selected for standby have the ability to carry one hundred fifty per cent load without appreciable droop in voltage, and one hundred per cent load at nearly double normal voltage, if we are to continue near full speed.

These voltages, of course, impose unusual duty on the generator. Obviously, one way to provide for this is to select the generator with double voltage rating or capability, and, as we view it, this is perhaps a major problem in duplicating the generator capacity.

However, there is one point in the paper which did not seem to be completely clear. The possibility of failure on the rotating regulator needs, perhaps, a little more emphasis. Presumably, on such a failure, the spare control is shifted along with its rotating regulator.

However, suppose, as an example, that a bearing on a rotating regulator failed. The rotating regulator set would go down and the entire installation would be down due to the failure of a small item, unless the duplicating generator setup is used and the machines are arranged to allow complete switching of generators, including their control.

This setup should accrue as an additional inherent advantage of the duplicate generator scheme. While with the other type of installation where it is not possible to shift more than one machine at a time, it would seem spare rotating regulator sources should be available as an equivalent to elaborate "backup" of controls.

Considerable effort has been expended on the mill mentioned in making all regulating machines duplicates, solely to minimize the spare and standby problem. Sizes are so chosen and field designs so coordinated that two of the standard regulating machines can be used in series to handle the largest generator fields. The regulator motor-generator sets are then broken down into units arranged so that the shutdown of one set will not shut down the mill.

It is very gratifying to us to see that study is being given to these practical aspects of the mill, and I am sure that added reliability will come on this type of equipment.

W. B. Snyder: The subject of this paper is one that arises whenever a blooming or slabbing mill is considered. Mr. Fennell quite rightly calls attention to the importance of service continuity on blooming mills and gives an analysis of several schemes used to further it. We are inclined to believe, however, that there are simpler and less expensive solutions that are entirely adequate. In this connection I would like to cite briefly the experience and practice of my company.

The first complete installation of adjustable voltage blooming mill auxiliaries went into service late in 1936 and incorporated what Mr. Fennell calls "emergency operation from screwdown generator" with transfer switches to effect the substitution quickly. In addition, the two m-g sets were lined up end-to-end, so that they could be coupled together through a removable shaft, permitting one set to drive the other in case of motor failure.

Later, transfer provisions became still more elaborate. In 1940 we built a d-c runout table equipment with such profusion of transfer switches that special name plates were supplied to show which way to throw each switch for each operating condition. This job, incidentally, incorporated the first rotating regulators in steel mill auxiliary service.

In 1942 we supplied the first set of rotating regulator controlled blooming mill auxiliaries, for a large aluminum rolling mill. Here we had two screwdown generators, two generators for each sideguard, and one generator for each table and feed roller combination. Each generator had its individual rotating regulator exciter and control panel, and transfer provisions were incorporated to permit operation of all drives at reduced speed even if one of the two m-g sets with its associated control panels and rotating regulator exciters was completely out of service.

Such involved transfer provisions were perhaps justified on the earlier installations when little operating experience was available. However, the drives proved to be surprisingly free from trouble, and we began to suspect that we had been penalizing our customers unduly in providing expensive, space consuming, and complicated transfer features.

In 1944 we installed an equipment that we felt incorporated a reasonable compromise, and this has worked out so well that we have been following the same basic scheme ever since. This equipment includes no transfer switches whatever. All connections are brought to terminal blocks at the rear of the control panels so that motors and generators may be readily shifted from one circuit to another by temporary cables. The m-g sets are laid out so that all drives may be operated at reduced rates, even with one set completely out of service. Only one control panel and one rotating regulator exciter are provided for each drive, even though certain drives, such as screwdowns, may have multiple generators. The normal spare part and spare machine stock take care of the amplidynes and control.

These drives have proven highly reliable. While there have probably been unreported failures, we know definitely of only two, and these both involved synchronous motor failures.

The likelihood of trouble on this equipment is remote, and when it happens it may occur in generators, exciters, driving motors, or control panels, and thus it seems logical to wager a problematical short increase in down time occasioned by the necessity of temporary wiring against the certain increase in first cost, floor space, and maintenance charges incurred by transfer provisions.

While a discussion of drive arrangements is perhaps outside the scope of this paper, I would like to impose on you a bit and say something about it.

The arrangements Mr. Fennell shows are widely used, but they are not necessarily correct for all installations. First, on screwdown drives it is always desirable to carry the motors to double voltage to obtain high speeds for long roll travels. However, the choice of one generator for each motor, or one of twice the capacity supplying both motors in parallel should be made on the basis of duplication of generator rating and the availability of spare generators. The same performance will be obtained with either arrangement.

Although many live tables driven by two motors have the motors connect in series across one generator, a study of inertias, gear ratios and speed requirements will usually indicate the desirability of carrying the motors to double voltage. This, of course, requires either one generator per motor, or the two motors paralleled on one generator of twice capacity. Here again, the selection of one or two generators should be based on duplication and emergency operating arrangements.

While many feed roller motors are operating in parallel with the motors on the adjacent live tables, superior performance and greater operating reliability is obtained by the use of separate generators for these drives.

Manipulator sideguards are universally driven by two motors. In those cases where the sideguards on the front and back sides of the mill are mechanically independent, it is necessary to supply one generator for each side. There seems to be a trend at present also to supply two generators in the more usual case where the front and back sideguards are tied together mechanically. I believe that this tendance is wrong and that the two motors should always be connected electrically in series across one generator. I have never seen a sideguard drive where the travel was long enough to permit the generator to get up to maximum voltage even with two motors in series. Thus the use of individual generators cannot result in improved sideguard performance and can be justified only on the basis of additional spare capacity.

As Mr. Fennell points out, there also seems to be a trend toward adjustable voltage operation of manipulator finger drives. It has never seemed to me that adjustable voltage on these drives results in any benefits to offset the large cost increase over constant potential magnetic control, and I would like to hear the opinions of the operating people on this subject.

James Farrington: We are very well equipped with spare equipment. We have a complete spare 1650-hp motor for the vertical drive on the 45-in. blooming mill, a complete 5600-hp motor driving the flywheel set, and a spare motor that we designed physically so that it will fit any one of the hot strip stand motor bases and drive any one of the eleven stands.

We also have a spare 2000-kw d-c generator for the motor-generator sets furnishing power to the hot strip mill, and a spare rotating regulator control set for the 45-in. blooming mill. We also have a spare 6000-hp blooming mill motor which was ordered for a new mill that has been temporarily delayed. We had an occasion to use this motor to replace the present 7000-hp motor in order to recondition it after twenty years service. We made the change in thirty-four hours, and we believe the cost of these spares have been well justified.

H. H. Angel: I agree that quite a few people would probably carry on hand a spare generator or a spare generator armature, maybe a few field coils, and possibly a spare stator for the motors driving these m-g sets. It seems to me that would be the least we could have in order to get out of trouble in the minimum amount of time.

F. C. Fennell: As Mr. Montgomery points out, failure of a small item such as a bearing failure on a rotating regulator set will result in a shut down of the entire installation on any of the systems described except the duplicate generator scheme. Completeness of coverage is the big advantage of that system, but is offset by higher initial cost, space, and maintenance requirements. The only answer to failures of this type on other systems is to carry spare units.

To reduce the number of spares and make the replacement problem simpler it has been our practice to make all rotating regulators duplicate on these installations. In some cases we have placed the driving motor at the end of the set thereby keeping conduit boxes all on the same side and facilitating the complete replacement of a unit.

Mr. Snyder has emphasized the possibility of using temporary wiring to shift units from one circuit to another in emergencies. The present trend toward increased use of solderless connectors at control terminal boards and at machines certainly makes the problem of temporary connections easier. Since practically every mill has at least one auxiliary drive using two generators, it appears that the "screwdown generator scheme" or a modification of it can usually be justified because it requires only a very slight addition in cost, floor space, and maintenance over an installation which has no emergency provisions at all.

PRODUCTION OF STEEL BY THE OXYGEN-IMPINGEMENT PROCESS

By TH. E. SUESS
United Austrian Iron and Steel
Linz/Donau
Austria

. . . . a translation of a section from the yearbook of the United Austrian Iron and Steel Works (Voest) at Linz . . . .

▲ THE possibility of using pure oxygen or oxygen-enriched air for metallurgical processes was mentioned by Bessemer in his patent about 100 years ago. Since then, there has been no lack of experiments in this direction, but the economic premises for the practical application of oxygen were not created until about 1928 by the Linde-Frankl method of producing oxygen. The international research association "oxythermique" was founded and had for its goal greater use of oxygen in metallurgical works. It supported full-sized experiments and thereby promoted the interest in problems that are connected with the metallurgical application of oxygen.

Today, progress of oxygen-technique in production and application has gone so far that almost all metallurgical plants are occupied in some manner with the oxygen problem. In this problem two approaches can be recognized: One is the use of oxygen in equipment already in existence, such as the blast furnace, the converter, the open-hearth furnace and the electric furnace. The other one is the development of fundamentally new processes for the production of iron or steel.

Austrian steelmen were always interested in converter-refining of pig iron from Styrian ores. Linzer pig iron suitable for steel production has the following composition:

	Per cent
C	3.6 —4.0
Mn	2.0 —4.0
Si	0.4 —1.0
P	0.1 —0.15
S	0.03—0.05

Although large-scale experiments in Hamborn (1938) and in Hagendingen (1943) showed that this iron could be refined in a basic converter, the heat-balance margin was found to be narrow and to cause metallurgical difficulties. On account of the high nitrogen content, the quality of the steel is not satisfactory.

It seemed almost obvious to attain a reduction of the nitrogen in the blast by enrichment with oxygen, as is done, for instance, in the Maxhutte Rosenberg, Bavaria, or to add even more oxygen with addition of water vapor or carbon dioxide, if this should be necessary for cooling the tuyeres.

Upon the suggestion of R. Durrer, the author decided in May, 1949, to make experiments with blowing pure oxygen down onto the bath in a converter-like vessel. In order to meet the difficulties which R. Durrer had predicted for this process, the experiments were begun in the smallest vessel suitable for this purpose, namely a two metric ton converter. They were later continued in a converter-like vessel that held 15 metric tons. In the consummation of the experiments, the thought was paramount that impingement-blowing from above permits working with higher temperatures than, for instance, injection of oxygen through tuyeres in the bottom. The highest temperatures arise at the place where the oxygen jet impinges upon the surface of the liquid iron, which is easily ignited at this temperature. The impingement area might be called the "hot spot." At that spot, the metallurgical reactions start. On account of this fact, the impingement process differs fundamentally from all other refining processes in which the metallurgical reactions take place over large areas or in the bath proper. Of course, reactions that start from one point

are predicated on a bath circulation from and to that point. This circulation is produced not only by the kinetic energy of the impinging jet, but even more so by the reaction-gases which are given off.

The phenomenon can be visualized by a laboratory experiment in which hydrogen chloride is blown on a concentrated soda solution. The slag can be simulated by oil and floating pieces of cork. The surface reaction pushes the gases downward and imparts to the bath the same direction of movement. In this phenomenon, the presence of the slag-cover plays an important part, because it obviously obstructs the escaping gases. At the same time, the bath rises somewhat at the rim.

It is essential, by proper cooperation of volume and pressure of oxygen, and of dimensions of vessel, to obtain a bath circulation that saves the refractory lining. The rising of the bath at the rim, produced by circulation in the bath, protects the lining from the heat which is radiated from the hot spot. Furthermore, it could be assumed that, with proper guiding of the bath currents, the bath near the rim performs endothermic reactions with those portions of the bath in which the reaction is still incomplete. This fact prevents the lining from reaching too high a temperature, although with high oxygen delivery extremely high temperatures are reached at the hot spot on account of the exothermic reactions. At the end of the refining period, the circulation of the bath ceases if proportions are right and the pressure of oxygen is moderate.

This process differs from the idea in the (German) patent No. 735,196/18b/8 in which a jet of oxygen penetrates deeply into the bath. Above all, an excessive absorption of oxygen by the bath can be avoided (in the present process) and a subsequent deoxidation is not needed.

Steel refined by oxygen is noticeably lean in gases. Convincing proof is the possibility of pouring 15-ton ingots of a steel which had been refined down to 0.02 per cent C and 0.2 per cent Mn, without subsequent deoxidation.

Until the fall of 1950, about 30 heats of 2.5 and 15 metric ton charge were refined. Figure 1 is a diagrammatic illustration of the fundamental arrangement. The 15-ton charges were blown in suitably rebuilt pig iron ladles of about 350 cu ft volume; they had been lined with rammed dolomite. Through a vertically suspended, vertically adjustable water-cooled tuyere of 15/in. inside diameter, oxygen of high purity was blown.

The following operative experiences were obtained:

1. Maintaining the correct distance between tuyere and surface of bath is essential. The pressure of the oxygen influences this distance.
2. When the tuyere burned through and leaked, and water entered the reaction space, no explosion occurred, as was expected. Nevertheless, safety measures for observing the stream of cooling water are recommended.
3. Ignition at the hot spot takes place almost instantaneously.
4. It is advantageous not to add scrap and lime at the same time.
5. The loss from spittings is very moderate; it can be reduced to a minimum by correct blowing and proper shape of vessel.

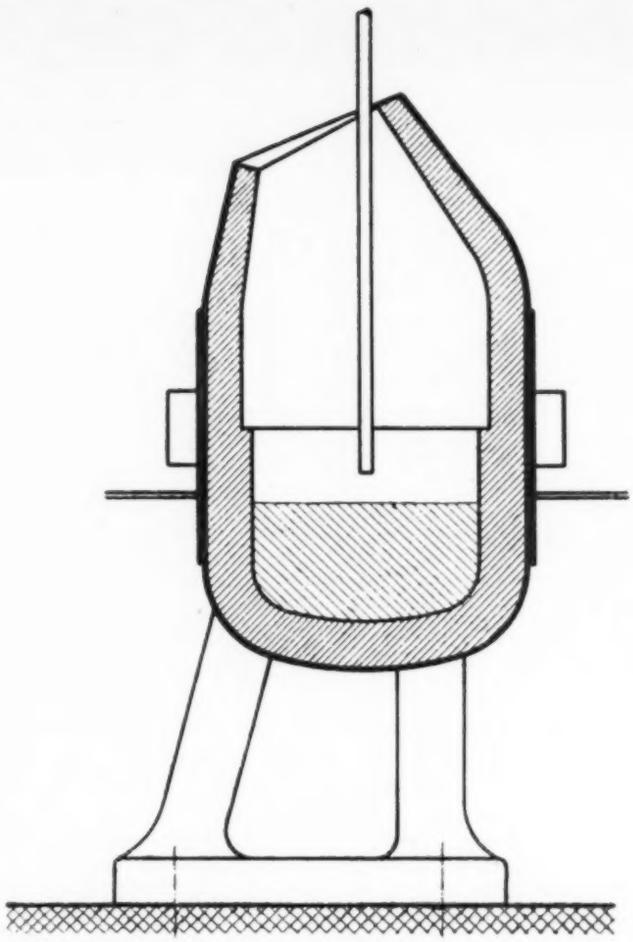
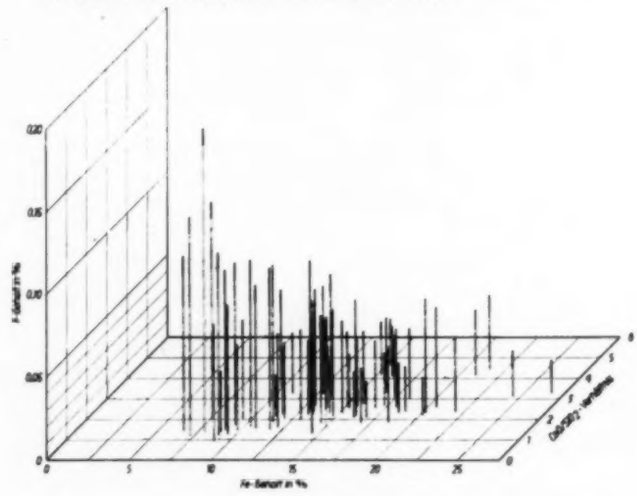


Figure 1 — Diagrammatic representation of the converter and of the tuyere for refining iron by impingement of pure oxygen.

6. The slag is very liquid and can be drawn off easily.
7. Measurements at the upper end of the discharge duct showed the following analysis of the discharged dust:

Figure 2 — Relations between phosphorous content of steel, iron content of converter slag, and the ratio of lime to siliceous acid. Inscriptions on ordinates are: vertical: P content in per cent; horizontal: Fe content in per cent; inclined: ratio CaO/SiO_2.



	Per cent
Fe	60.74
Mn	5.46
SiO_2	1.65
CaO	1.95
MgO	0.60
P	0.105
S	0.105

The weight of the discharged dust was 34 lb per net ton of steel, or about 4.4 gr per cu ft of waste gas. In view of this considerable evolution of dust, particular attention will have to be paid to deducting.

8. The heat balance, referred to one net ton of steel looks approximately as follows:

	Btu	Per cent
Heat Input		
Sensible heat in pig iron	860,000	52.60
Heat of reaction	772,000	47.40
	1,632,000	100.00
Heat Output		
Sensible heat in steel	1,090,000	67.22
Sensible heat in slag	214,000	13.11
Sensible heat in carbon monoxide	123,000	7.52
Radiation, conduction, spittings, skulls, etc.	205,000	12.15
	1,632,000	100.00

In comparison with all other refining processes (the bessemer and Thomas processes included), the process discussed here has the most favorable heat economy because of the small quantity of slag and because of the absence of nitrogen ballast.

9. Iron with phosphorus content up to 0.3 per cent could be blown. In the absence of experimental proof, it may be assumed that higher phosphorus will not cause any difficulties. In the regulation of slag and in the addition of lime, this must be taken into consideration.
10. Scrap can be added up to 30 per cent of the liquid charge; with continuous operation this value can probably be increased.
11. The life of the refractory lining is satisfactory, if rate of oxygen supply, bath area and depth are properly proportioned.
12. For the oxygen tuyere, designs exist which guarantee a sufficient durability. The oxygen consumption per net ton of finished-blown steel lies (varying with the scrap charge) between 1700 and 1900 cu ft (60 F, 14.7 psi) and thus corresponds almost to the theoretical requirement.

The relations between composition of slag and phosphorus-content in the steel are illustrated by Figure 2. The following conclusions can be drawn from the results:

1. The dispersion of the values and their relations to one another reveal the influence of the final steel temperature and of the after-blow period. More detailed investigations on this problem are now under way.
2. The FeO content of the slag rises as the phosphorus content of the steel drops. In judging the higher FeO content of the slag, which occurs especially with low phosphorus (0.02 per cent or lower) in the steel, the small quantity of slag (7 to 10 per cent) must be considered. In the Thomas converter it amounts to 20 per cent of the liquid charge, and even more.

The high temperatures which occur in this process and the peculiarity of the reactions in slag and bath promised exceptionally favorable effects upon the steel quality. Careful examination of the 4000 tons which have hitherto been produced confirmed this expectation.

Unalloyed carbon steels up to about 0.25 per cent, when compared to normal open-hearth steels, showed a superiority in cold-deformability and in weldability. Soft wires, for example, could easily be drawn from 0.216 in. to 0.012 in. without intermediate annealing. Especially well deformable steels with 0.04 per cent C and with Mn below 0.25 per cent, and with extremely low contents of P, S and N_2, can in a simple manner be produced by this method of refining by oxygen.

For steels with higher carbon content, the ductility properties of the oxygen-refined steels are superior to those of open-hearth steels. The hardenability is the same as it is for open-hearth steels and can probably be eliminated. No reason exists to doubt that low-alloy steels, such as transformer steel, chromium case-hardening steel, free-cutting steels, etc., can be produced in excellent quality by this oxygen refining process.

Killed steels and rimming steels can be produced with equal sureness of results. Reaction-finished steels, blown by this process, and almost entirely free from blowholes and segregation, result in a higher yield in the rolling mill than do the conventional steels made in open-hearth furnaces and converters.

Summarizing, it may be stated that, by blowing pure oxygen down on a bath of iron in a converter-like vessel, a steel can be produced which is in no manner inferior in quality to open-hearth steel and even exceeds it in many essential properties. Design of tuyere, shape of vessel, dimensions of bath area, and depth of bath, as well as rate of oxygen supply, must be properly tuned to one another if good results are to be obtained. Pig iron can be so refined with oxygen that the blown steel needs no deoxidizing additions. This fact probably characterizes better than anything else the peculiarity of the new refining method. With the present costs of producing oxygen, refining of suitable pig iron in a converter is cheaper than production of steel in the open-hearth furnace. When steel is refined by oxygen, up to 30 per cent scrap can be charged.

Patent applications have been made on the process, on some equipment, and on the production of steel of special qualities.

MODERN HYDRAULIC APPLICATIONS

By JOHN R. CARLSON
Berry Div.
Oliver Iron and Steel Corp.
Pittsburgh, Pa.

. . . . recent developments in hydraulic machinery indicate that the hydraulic manufacturing industry is on the threshold of a period of widely expanded application of hydraulic motors . . . .

▲ HYDRAULICS, according to Webster, pertains to water or other fluids in motion. A fluid by definition is anything that flows, whether liquid or gaseous.

Under this subject we could conceivably carry on discussions for days about rivers and harbors, steam and water turbines, air and gas compressors, centrifugal pumps, torque converters and so on. However, the use of the word "hydraulics," in recent years, has been consigned more and more to the field of volumes of oils in motion under pressure to perform work. We see articles and advertisements on hydraulic steering of buses, trucks and now private automobiles. We would not own a car today without hydraulic brakes, though many of us have driven cars of earlier vintage with mechanical brakes.

The subject matter today will deal only with the modern uses of oil hydraulics in motion and the manner in which this relatively new means of power transmission is being applied to solve complex problems for industry.

All of us are familiar with the various hydraulic ram applications such as on hydraulic presses, sheet metal bending breaks, dump truck and bulldozer blade cylinders, hydraulic elevator columns, and similar examples of the multiplication of force through the medium of oil under pressure.

The aviation industry has utilized the medium of hydraulic pressure to make it possible for pilots to manipulate plane surfaces many times larger than any conceived by the Wright brothers. Hydraulics is used to raise or lower the landing gear, to lower the wing flaps, and to vary the pitch of the propeller blades.

Every farmer is becoming educated to the hydraulic age and now buys his equipment with hydraulic attachments that will, at the touch of a control lever, lift the plow out of the ground or put it deeper into the ground,

Figure 1 — Cross-section of a common valve unit.

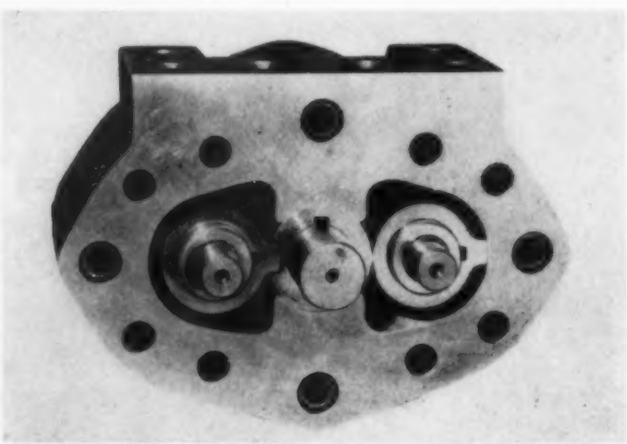
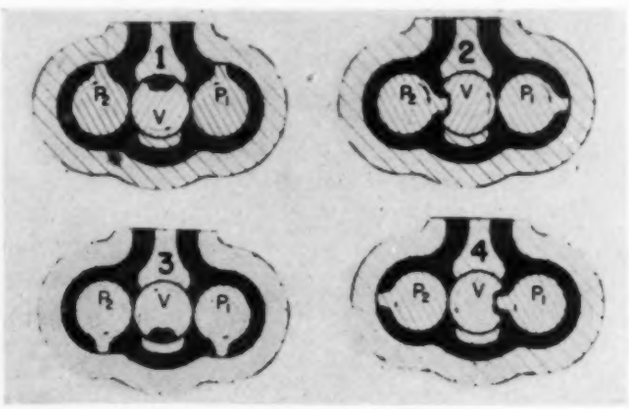


Figure 2 — The rotating elements are shown in four 90-degree positions.



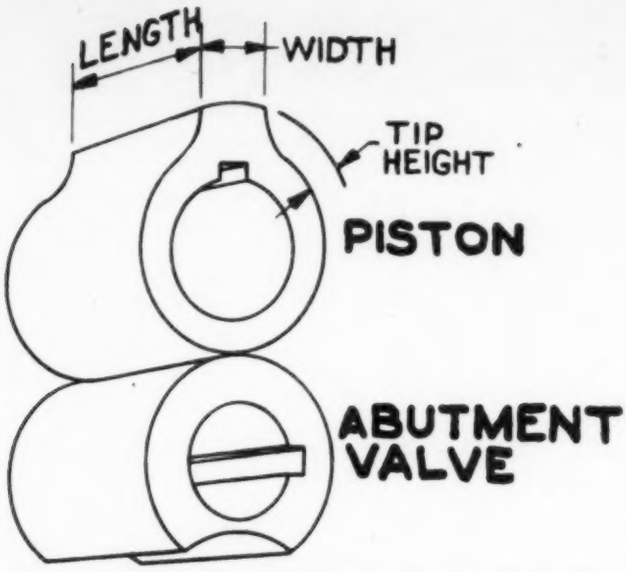


Figure 3 — Valve and piston are shown in this sketch.

and will operate mower bars at any angle of inclination, that will dig post holes or trenches.

Industrial engineers, as they carry out their assignments of product or plant improvements, are continually seeking better means of performing certain operations. Some of these modernization steps are taken through the necessity for safety in operation of machinery in general or of equipment in hazardous areas. Others trend toward hydraulic power transmission because of the inherent high starting torque obtainable with a relatively small unit, the simplicity of controls and the ease of reversibility. More and more of these engineers are turning to the hydraulic equipment manufacturer for assistance in analyzing power transmission requirements and recommending suitable equipment.

Mobility has pushed the internal combustion engine into the fore and has made possible the wider use of mobile power plants in such equipment as sawmills, blast-hole drilling machines, transit concrete mixers and many more. However, if the engine must run at constant speed for one of the ultimate functions, and it is desirable to have another function operate intermittently and reversibly at variable speeds, the design engineer is faced with complications which can best be solved through the use of hydraulics.

In discussing the transmission of hydraulic power, we mean not only of linear motion but of rotary motion. This presupposes not only the requirement of a hydraulic pump to transfer the oil from storage to the line and to simultaneously raise the pressure of that oil, but it also requires a unit at the point of power usage which will transfer that hydrodynamic force into rotary motion in the form of torque and speed. This power output unit is known as a fluid, or hydraulic, motor.

Since the transmission of one horsepower requires the pumping of approximately one gpm at 2000 psi, the size unit needed for a given application is roughly known as soon as the horsepower is determined. Where variable speed is required, the pump or motor, or both, may have to be increased in size in direct proportion to the maximum/minimum speed range desired

Efficiency of power transmission is always important, though consumer demand or other exigencies may dictate that it be evaluated to a lesser degree than initial cost or even cost of operation. In this connection, reference is made to a dump truck application of hydraulic cylinder actuation. The engine under the hood may be 100 to 200 hp, and the hydraulic pump may require only one hp to pump two gpm at 1000 psi. As this pump would operate on a highly intermittent cycle, and there is horsepower to spare, a low cost unit is generally used.

On the other hand, the manufacturer of mobile power plants looks for the maximum efficiency in such applications as transit concrete mixers, continuous mining machines, mobile refrigerated trucks, portable sawmills and liquid fuel transports. An inefficient transmission will generate heat which must be dissipated and the mobile power plant can ill afford the space, weight, or cost of hydraulic oil cooling equipment.

The Army, Navy, Air Force and marketing branches

Figure 4 — Inlet and outlet openings have been channeled to provide smoother flow.

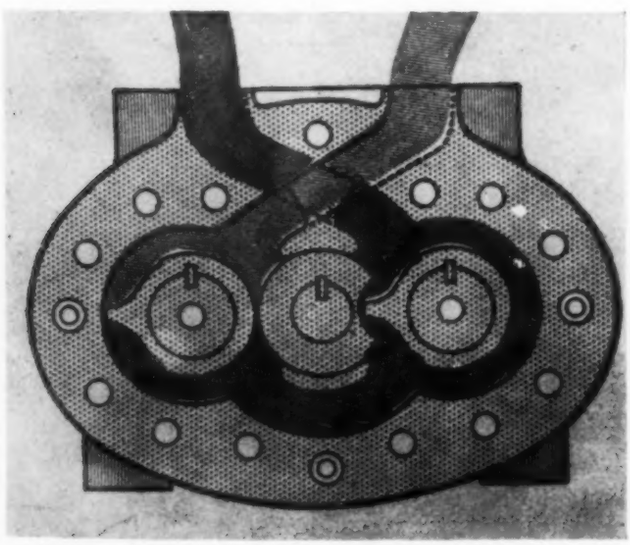
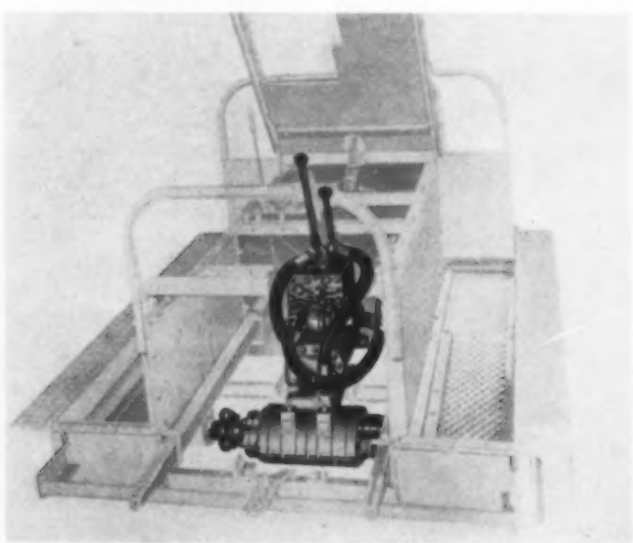


Figure 5 — Railway maintenance car is powered by hydraulic transmission.



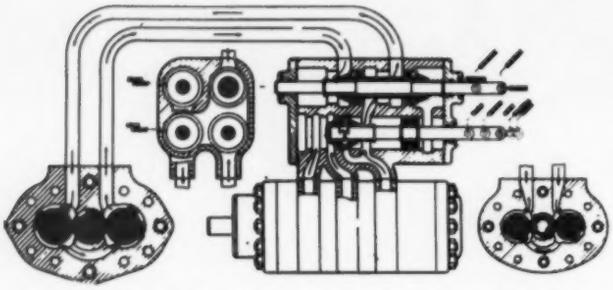
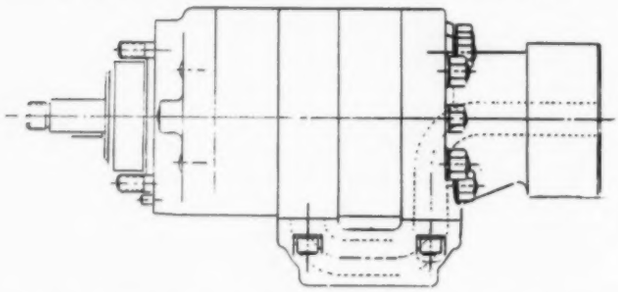


Figure 6 — Schematic design of drive for Figure 5.

Figure 7 — This unit is used in fork lift trucks.



of the petroleum industry responsible for handling liquid fuels have already recognized the safety features involved in utilization of hydraulic transmissions. Contracts have been awarded for highway liquid fuel transport tractor-trailer combinations specifying that hydraulic pumps be driven from the engine power take-off to supply oil to hydraulic motors on the trailer. These hydraulic motors, in turn, are driving product pumps handling the liquid fuel. This explosion proof transmission is immeasurably safer than the frequently-used arrangement of driving a 100-octane gasoline pump with an internal combustion engine where a hot exhaust might touch off leaking gasoline to cause an explosion.

Hydraulic equipment manufacturers are supplying pumps and motors for such drives on butane and oil delivery trucks where the owners complain of considerable difficulty in maintenance of the product pump underneath the truck where it is subjected to dust, water and physical damage. A mechanical drive from tractor to semi-trailer has complications easily solved with flexible hydraulic hose lines. The power is transmitted smoothly and efficiently, yet the trailer has full freedom of movement on the kingpin. Furthermore, the tractor can be separated from the trailer without loss of hydraulic fluid since modern self-sealing couplings are available.

The industrial engineer, for stationary installations of hydraulic power transmission, must consider the best available efficiency in order to reduce first costs of equipment, maintain low power consumption rates, and conserve valuable floor space.

Hydrodynamic power transmissions have been, except in a few cases, heretofore relegated to the lower range of 50 hp and less. Recent developments have made possible the opening up of the range to as high as 1000 hp, though the marketing range will probably not exceed 300 hp for the immediate future.

Our company is manufacturing and marketing a new development in hydraulic equipment which promises to open many more possibilities for the application of this medium of transmission.

To best appreciate this new concept of rotary power generation and utilization, the following illustrations will show the principle, installation photographs and some circuit diagrams. Outstanding is the very simplicity of design characterized by the two basic moving parts. Consider also that the uniform cross-section of the liquid path insures uniform liquid velocities so that pulsation from this aspect is non-existent.

Since the time of Nero, some 2000 years ago, engineers have sought a positive displacement continuous flow machine.

Figure 1 shows photo of a cross-section of a common-valve unit. The right and left-hand members are known as pistons, while the center member is the abutment valve, or rolling seal.

Figure 2 shows four 90 degree positions of the rotating elements. The three shafts shown are geared together in a 1:1 ratio. The two pistons alternately work through 180 degrees and transit the common abutment valve through the next 180 degrees. At any one moment, full load is carried by one piston only. Note the single passage channel for flow of fluid, providing smooth continuous flow through 360 degrees of rotation whether used as a pump or as a motor.

The symmetrical arrangement permits both pumps and motors to operate in either direction of rotation.

The laminated plate construction permits the stacking of basic cylinders by the simple expedient of using longer shafts and body bolts, to obtain higher capacity pumps and to contribute to the feasibility of variable speed operation through proper valving.

There are now two series of production units available, and the illustrations shown hereafter cover uses being made of these units. One series, which can be stacked to three places, is rated at 9.4 gpm displacement per place at 1500 psi continuous. These units will operate for intermittent service at higher pressures, and will take shock surges of 200 per cent of continuous pressure. While nominal piston speed is 1750 gpm as a pump, higher or lower input speeds may be used since our engineers have designed gear reducers or increasers into the drive ends of several models. When used as fluid

Figure 8 — Hydraulic motor is used to operate vibrating screen.

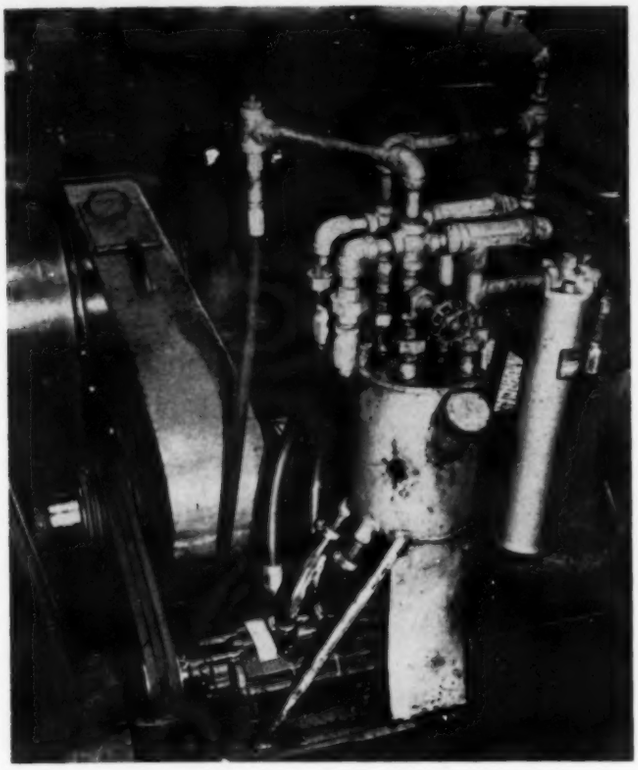


Figure 9 — Hydraulic motors are used in oil field work on drilling rigs.

motors, piston speeds of 2500 rpm and higher are permitted since the inlet is supercharged. At this speed and 1500 psi, this series is rated hydraulically at 11.6 hp per place.

The other series, which can be stacked to four places, has a displacement of 60 gpm per place at 300 psi continuous and at 650 rpm. Several hundred of these models are in service in the oil hydraulic elevator industry, where the inherent features of negligible pulsation and very low noise level are gaining widespread acceptance. No drive gear ratios are provided in this low pressure series. When used as fluid motors, these units can operate up to 1500 rpm, with a hydraulic horsepower rating of 40 hp per place at 500 psi.

No gaskets are used between stacked plates, thus giving a tight unit without leaks.

The cross-section of the passage from inlet to outlet remains uniform, so that velocity changes and resultant power losses are eliminated. There is no rubbing contact between rotating and stationary members. If the hydraulic oil is kept clean by proper filtration, there is no reason for the design clearance to increase through use. This absence of metal-to-metal contact eliminates the main source of heat generation and power loss existing in most other hydraulic units.

Figure 3 shows a piston and valve. From a known mean radius, tip length and tip height, we can determine the displacement per revolution of the piston.

Knowing the mean radius and the area exposed to the column of oil and the pressure, we can arrive at the torque rating. In this unique design it is important to note that the piston tip is a positive unbalanced couple so that, when a column of oil under pressure is directed against the piston, it must rotate.

For this reason these units are unusually well adapted to handle high stall and starting torques, and speeds down to stall are obtainable. If the piston length were constant for two different rotor diameters, the horsepower, torque and displacement would increase with the square of the rotor diameter. However, since piston length increases with larger diameters, the rating of a unit actually increases in a proportion somewhere between the square and the cube of the rotor diameter.

From this it can be seen that the power and torque rating of the design increase rapidly with small increase in physical dimensions.

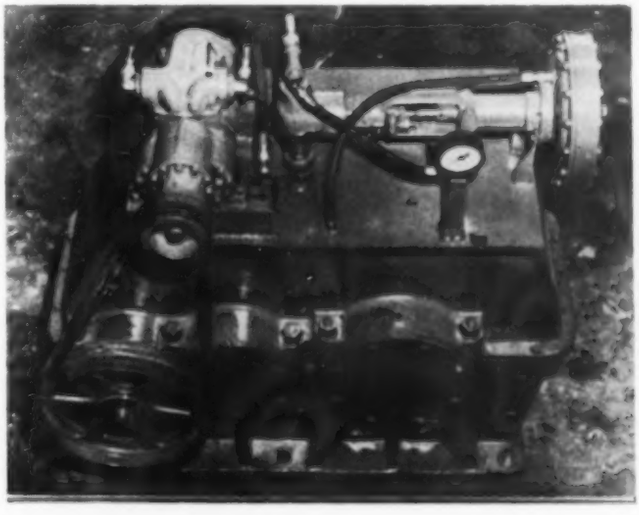
Figure 4 is a modification of the channelling of the inlet and outlet openings to provide smoother flow with lower turbulence losses.

Tests are still proceeding, and these units have been tested with fluid velocities of as high as 25-30 fps.

Engineers of the mechanical branches have always been quick to visualize the application of hydrodynamic power transmission to the four wheels of a tractor or automobile. Many attempts have been made to use gear, vane and piston motors, but the results have not borne fruit for various reasons such as: efficiency, life, initial cost, reversibility, or speed.

Figure 5 shows what is believed to be the most successful tractive transmission placed in a vehicle. This is an installation photograph of this hydraulic drive on a railway maintenance car. The pump is a three-place unit with 1½-in. rotor diameter incorporating a built-in speed reducer to reduce from maximum engine speed of 3200 rpm to piston speed of 1750 rpm. The motors are single place series units with 2-in. rotor diameter. By increasing rotor diameter in the motor, a torque increase is effected because of the longer radius; while the larger volume swept results in a speed reduction. The prime mover is an 18 hp Waukesha gasoline engine, with a 3200 rpm governor. The car is capable of running at 45 mph in either direction, and it is possible to shift from full ahead to full reverse with five passengers in less than one minute without stripping gears, breaking belts, or burning up any clutches. Another asset is the full differential action obtained in

Figure 10 — An interesting application of hydraulic motors is for absorption of power in braking devices.



the double motor, which is actually two motors back-to-back, with common inlet and outlet connections. Figure 6 shows a section through the hydraulic circuit of this transmission.

As previously mentioned, this design (Figure 6) provides for stacking of basic parts to allow additional capacity. By the same token it provides for controllability of the places independent of one another to give variable speed operation with a minimum of throttling. The pump is directly connected to the Waukesha engine without the necessity of a clutch, since the frictional drag in the unit is exceptionally low. The control chest, by bolting directly to the pump, eliminates several potential leakage points.

By so valving the two motors as to place them in series for high speed operation, this car could approach a speed of 90 mph. Other applications of these units to mobile tractive transmissions are readily apparent for such uses as fork-lift trucks, mine locomotives, tractors and straddle trucks.

Clutch maintenance is completely eliminated, resulting in greatly increased use factors of material handling machines. Furthermore, hydraulic lines give a degree of flexibility of movement not possible with mechanical shafting and gears.

Figure 7 is an outline of a modified single place motor which is being used for tractive power by one of the largest manufacturers of fork-lift trucks. This unit is to be released to the public in the beginning of 1952. Note how the fluid enters and leaves the motor axially, yet is directed to the cylinder plate through the special adapted manifold. This motor is approximately 8½-in. long by 8-in. wide, and develops 11 hp at 2500 rpm and 1200 psi. The manufacturer selected the unit on the basis of high stall torque, rapid acceleration, lower maintenance, simplicity, and reversibility characteristics. This is believed to be the first application of hydrodynamic power transmission to the wheels of a motive vehicle in regular large scale production, and further emphasizes the trend in industry toward this mode of power transmission.

The production division of the petroleum industry presents operating problems and requirements which are somewhat akin to those found in the mining and steel industries, in that ruggedness is a prime requisite

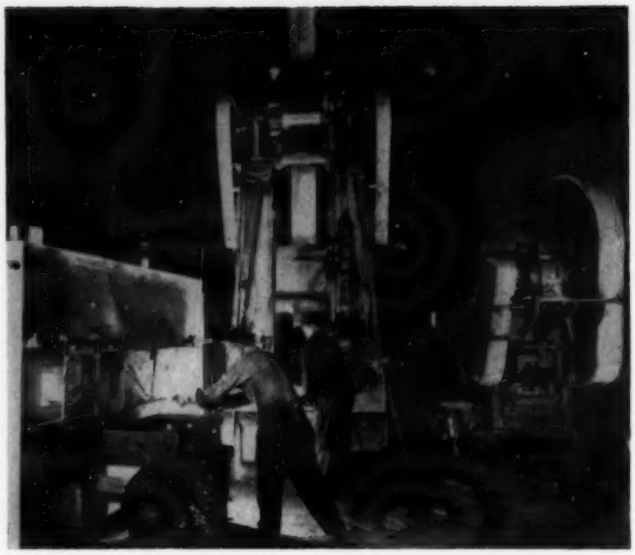


Figure 12 — Hydraulic lines for forging hammer.

Figure 11 — Pump installation for forging hammer.

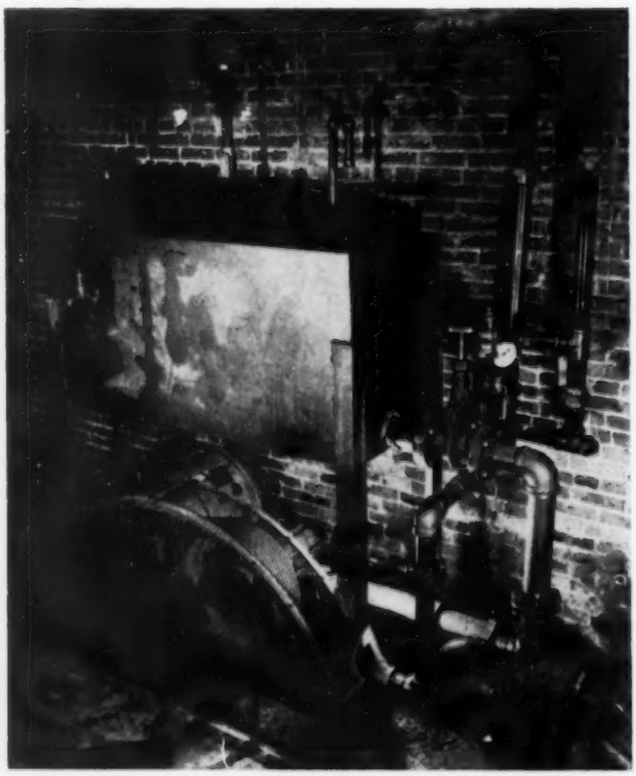
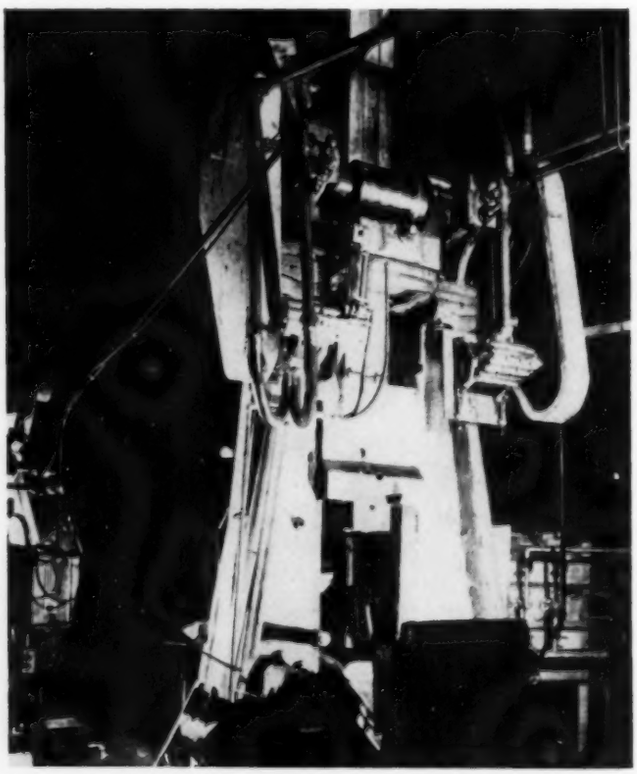


Figure 13 — Rear view of hammer. Note hydraulic motors mounted on the unit. Each motor drives one roller.



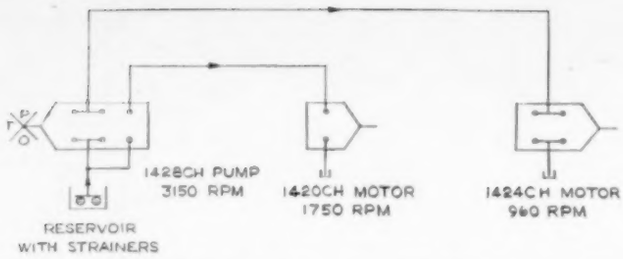


Figure 14 — Sketch shows a simplified hydraulic circuit with parallel motors.

followed closely by simplicity, low maintenance and long life. Our units have met the test in the oil fields and some of the early units are approaching 20,000 hr of virtually continuous 24-hr service.

A drilling rig may consist of two, three or four engines, depending on the territory and the depth of hole to be drilled. In every case the drilling engines, when the drill steam is "on bottom," are not developing full load, and a considerable amount of unused horsepower is available. Our pumps and motors have made possible the efficient use of this lazy horsepower, and the following figures illustrate some of the applications.

Figure 8 shows a 5-hp, hydraulic motor operating a vibrating screen. The hydraulic pump supplying this motor is 100 ft away, on the rig operating floor, making a circuit length of 200 ft. Note the comparative size of the 2½-hp, d-c electric motor.

roughneck has picked up a piece of pipe only to find it grounded. While electric lights are a necessity, the generating unit can be much smaller and less expensive when hydraulic power is used to operate these auxiliaries. Note the small size of the reservoir, about 3 gal, for an 18-gpm pump.

In most cases the study of the application of hydraulics deals with the *transmission* of power from the prime mover to the point of use.

In Figure 10 is shown the application of a unit to the *absorption* of power when used as a braking device.

Many of these units are on active duty in the oil fields as a controlling device for the rate of descent of the drilling stem into the well. The braking effort is accomplished by throttling the discharge of the unit which is being driven by the cable drum, thus imposing a resistance or braking torque.

Our engineers are daily receiving application inquiries involving the use of hydraulic pumps as braking devices on backstand reels in paper mills and wire forming plants, and on machines used for inside coating of concrete and steel pipes. Dynamic electric braking is expensive, and friction slip-clutch brakes involve considerable maintenance. Hydrodynamic braking, with proper facilities for cooling, provides the ultimate answer.

An application which startled even the equipment manufacturer was the conversion of a mechanically driven board type forging hammer, and Figures 11, 12, and 13 show such an installation.

Figure 15 — Sketch shows a simplified hydraulic circuit with series motors.

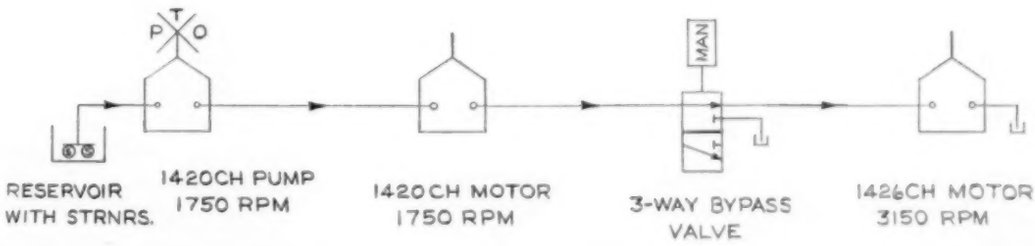


Figure 9 shows a two-place unit, again on a drilling rig, illustrating another versatile point. Each place is independent of the other. One place supplies oil to the vibrating screen motor 24 hr per day. The other place supplies oil to a motor driving a water pump which is used only two or three hr per day. At all other times, this place is unloaded and circulates oil back to the reservoir.

Oil field drilling equipment is subjected to all possible weather conditions which are not always kind to small gas engines or electric motors. The application of hydraulic transmissions in these instances was made to overcome the shortcomings of the other types of prime movers. A small gas engine, at zero degrees in a biting wind often presents a rather difficult cranking problem. Moisture, prairie dust and vibration have probably increased the difficulty. It is much easier on personnel to be able to close a valve on the rig operating floor and see the auxiliary equipment start without waiting.

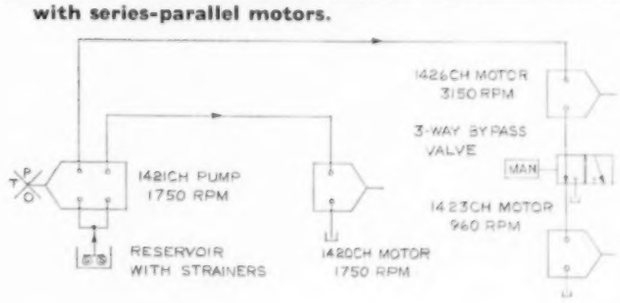
Electric power is seldom available at those spots where mother nature decided to put an oil pool, and drilling contractors must haul auxiliary power generating units along with the rig. Electrical wiring around an oil well presents a fire hazard, and more than one

Figure 11 shows the pump installation with the 30-hp electric motor and the 100-gal reservoir. This pump is a two-place unit rated at 120 gpm at 650 rpm and 500 psi. No-load pressure on the circuit is 100 psi.

Figure 12 of the board hammer shows the hydraulic lines passing almost directly over the top of the heating furnace.

Figure 13 is the rear view of the board hammer, and you can now see the pair of two-place motors mounted on the hammer. Each motor drives one roller. While the hydraulic system absorbs the impact shock which

Figure 16 — Sketch shows a simplified hydraulic circuit with series-parallel motors.



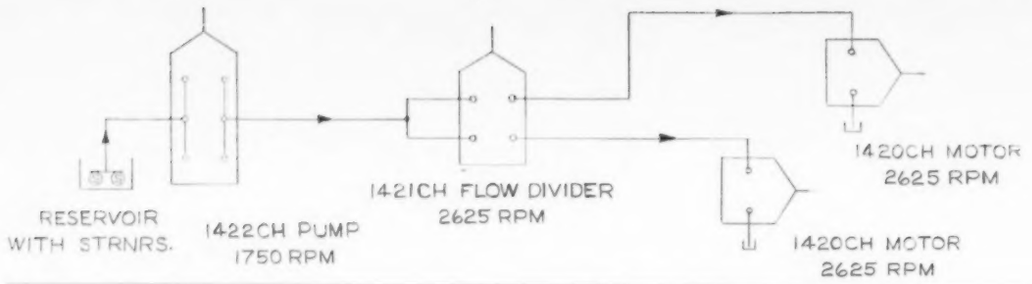


Figure 17 — Sketch illustrates flow divider application in simplified hydraulic circuit.

was formerly absorbed by spur gears, there is no diminution of speed of operation of the hammer.

At the operator's control, the hammer falls free to strike the die. When the hammer hits bottom, mechanical actuation causes the rollers to grasp the board and raise the hammer into striking position again. The total weight of 2300 lb is accelerated at the rate of 5.4 fps in one second. The circuit pressure surges over 900 psi at the moment the rollers grasp the board. You have probably noted the absence of any cooling equipment, which will attest to the low heat generating characteristics of the design. Having been in operation for over four months, the following advantages of hydraulic

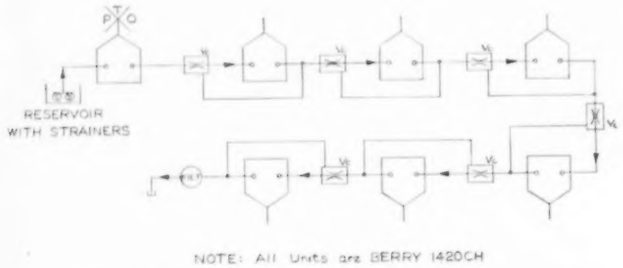


Figure 18 — It is easy to apply multi-motor units in a series circuit.

power over mechanical drive on the board hammer have already become apparent:

1. Boards last longer due to less shock.
2. Less down time to change boards.
3. Lower maintenance cost.

A second board hammer, near this one, is now undergoing conversion to hydraulic drive.

Inasmuch as this application illustrates the low inertia characteristic of the hydraulic power transmission, engineers are attracted to this design for such applications as propelling log carriages on sawmills, driving the rolls of rolling mills, powering planing tables, on crane hoists for ingot removal, and in paper mills for driving or braking the rolls.

The following circuit diagrams will further illustrate the versatility of this unique design.

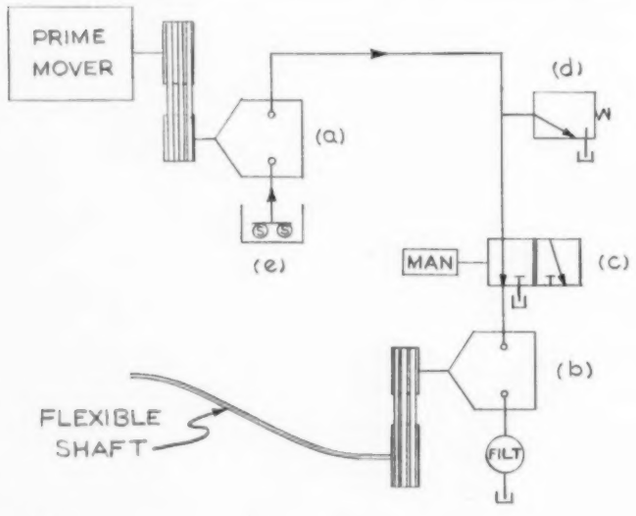
Figure 14 shows a three-place pump with two places manifolded for one circuit to a two-place motor; and the other pump place supplying a separate single place motor. Note speeds of each of the components. This interjection of different speeds is made possible through built-in gear ratios in the drive ends of the units to provide a wide range of models. All three units are assembled from component parts from the same production line.

Figure 15 shows a simple series circuit, again illustrating the different speeds obtainable. This is another application wherein the left-hand motor drives a vibrating screen 24 hr per day, while the right-hand motor drives a centrifugal pump intermittently as required.

Figure 16 is a third version incorporating the features in Figures 14 and 15 with variations.

Figure 17 illustrates the use of a two-place unit to positively divide the flow from a pump into two equal (or otherwise) proportions where it is desired to operate two motors in definite relation to each other. Since the two places of the flow divider are positively locked together by shafting and gears, one place cannot possibly meter any more fluid to its motor than its proportionate share. This relationship will hold true even through a wide range of viscosity.

The unit does not require casing drainage, and consequently can be operated with line pressure even on the outlet side. For that reason it can be operated in series with other units. See Figure 18 which shows an



LEGEND

(a) BERRY 1420CH Pump
(b) BERRY 1420CH Motor
(c) ½", 3-Way Valve
(d) ½", Relief Valve
(e) Reservoir with Strainers

Figure 19 — Sketch shows experimental hydraulic drive for a tapping machine.

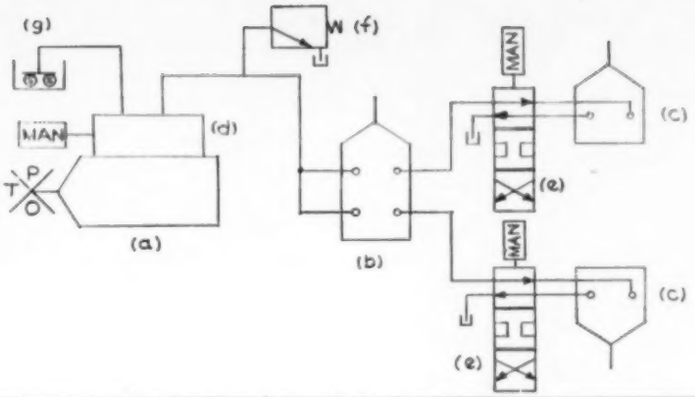


Figure 20 — Hydraulic traction drives have been applied to coal mining machines. It is believed explosion hazards will be minimized with such equipment.

arrangement of seven identical units, but with the provision that the speed of each motor can be varied without affecting the speeds of the other units.

Recently a major oil company near Chicago wrote several hydraulic equipment manufacturers for information on a proposed drive for a pipe-tapping machine. See Figure 19. This device is used to tap into gas or oil pipelines for the purpose of teeing into the main line, and permits this operation to be done even with the line under pressure. The customer's engineer advised that the application was in a hazardous location and they wanted portability so that connections could be made at any location.

The operation of the pipe-tapping machine is preceded by the welding of a sleeve around the pipe at the point where it is to be tapped. Therefore, a welding machine is always required at the site.

Previously, the pipe-tapping mechanism was driven by an air-motor, which, of course, required that a large portable air compressor be transported to the site also. We were the only hydraulic manufacturer to offer units for this application, and standard units were selected and supplied.

The customer no longer needs to transport an extra 3000 lb portable air compressor through swamps and forests to perform a 3½-hp job and the efficiency of the hydraulic drive is considerably higher. The pump is driven by the welding machine engine, located 100 ft from the point at which the pipe-tapping operation is to be performed, so as to avoid an explosion from possible gas leaks.

Figure 20 shows a proposed traction drive for a continuous coal mining machine. Such a transmission will permit the use of alternating current motors, since the hydraulic circuit can provide the variable speed and reversing features so desirable to close quarter working of mines. Note again the use of the flow-divider application to provide equal volumes to the two traction motors. Hydraulic transmissions are self-oiling, dust tight, and explosion proof, which appeals to mine operators. The number of electric motors, wiring and controls, with attendant explosion hazards, can be considerably reduced. This is extremely important in these days of copper shortage.

The marine industry is extremely interested in the increased potentialities of the use of hydraulics on cargo winches, capstans, and anchor windlasses. The circuit shown in Figure 21 is now undergoing preliminary tests in the East.

As the torque requirements of the motor increase, the hydraulic pressure increases, and the volume of oil to the motor is reduced through the actuation of sequence valves which unload the two pumps place by place.

The completely sealed hydraulic motor on deck is impervious to the ravages of the weather and maintenance problems are minimized. Controls are simple and compact. High starting torques at low speeds allow ease of manipulation of the cargo and yet the low inertia

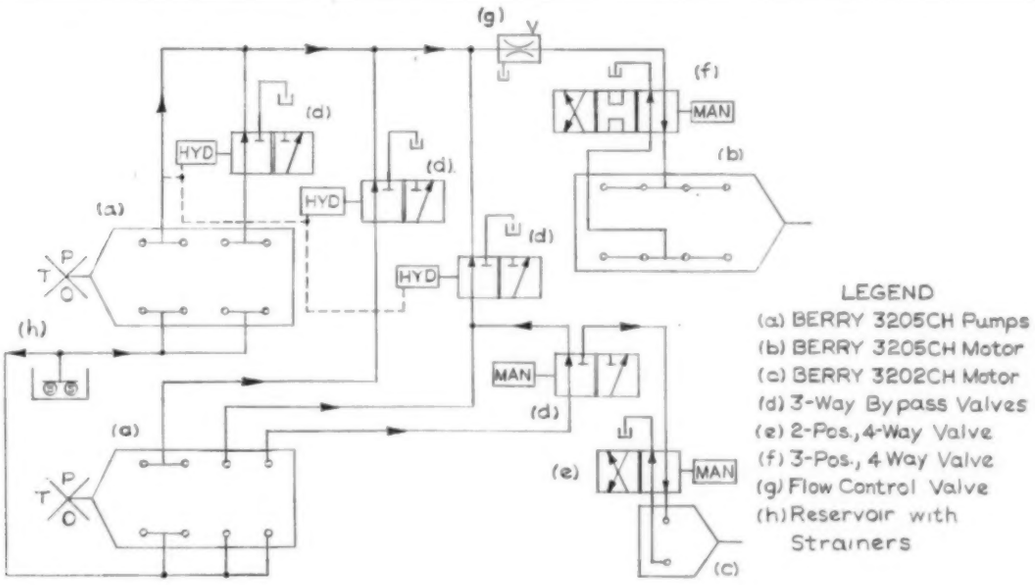


Figure 21 — Marine cargo winch is driven by hydraulic motor.

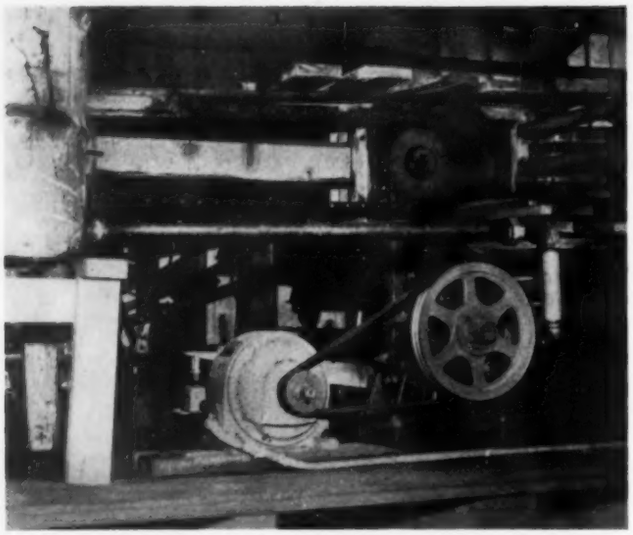


Figure 22 — Automatic plate stackers which are driven by hydraulic motors can be adopted by industry for stacking up other items such as lumber.

component in the hydraulic motors permits rapid acceleration for faster loading.

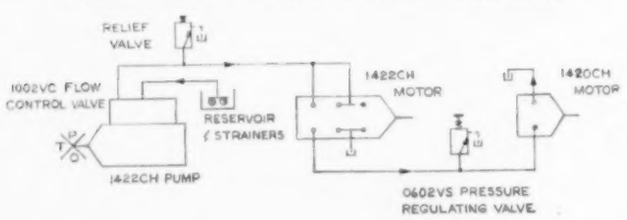
Figure 22 shows a new device you have seen in restaurants which consists of a recessed well in a table with a coil spring having variable compression characteristics so that when plates are stacked in this well, there is always one at table top level regardless of how many plates are in the well.

We now have a parallel example in the stacking of lumber on cars as shown on this figure. The lumber car is moved onto a platform which can be raised or lowered on a large hydraulic cylinder. The conveyor loads the planks on the car and as each layer is completed the hydraulic pumps lowers the car a predetermined distance to permit the stacking of the next layer. The stopping and starting action is controlled by limit switches, and a solenoid brake on the electric motor positively stops the pumping action at the desired setting. This application has been pioneered by a well-known Alabama lumber company.

Application recommendations have been made to similar stackers for sheet steel.

There are many applications in the paper and textile manufacturing and processing industries and in the wire drawing and coating industries, which involve the reeling or unreeling of paper or wire. As the material on the re-wind reel builds up it is necessary to increase the torque of the driver while reducing speed, since constant material speed must be maintained. Another example of the unique versatility of the unit is shown on Figure 23. Note how variable speed is controlled by by-passing fluid at the pump outlet, yet the reel motor maintains a fixed relation of speed to the capstan motor. This is another variation of the flow-dividing use discussed on an earlier figure.

Figure 23 — Sketch shows a wire extruder drive.



This installation is in service in the East on a wire-coating machine. The manufacturer of the machine reports considerable saving in initial cost and in space over equipment previously used.

These few examples of widely separated applications of hydraulic units in the industrial field are not idle visions of a market research analyst, but actual installations successfully serving industry daily. New applications are being conceived every day as engineers begin to realize the tremendous advantages of hydraulic power transmission. Among the many applications and modified variations possible with the rotary piston principle are successfully built experimental hydrodynamic transmission of 225 and 1000 hp, both utilizing the patented features embodied in the smaller standard products being applied to industry in the examples discussed here.

The 225-hp experimental drive was built as a marine twin screw transmission powered by a single prime mover, with controls provided which would permit independent three-speed control of each propeller, ahead and astern.

While facility of installation is comparable to that of an electric drive, this marine hydraulic transmission could even run submerged without short circuits, and would weigh less than an equivalent electrical transmission. Marine architects appreciate the fact that the use of hydraulics eliminates the necessity of locating the engine in the boat in a fixed location with respect to the propeller. A hydraulic drive would obviate the need for all but short propeller shafts, and line shaft bearings would not be required. The engine can be located anywhere in the boat to provide maximum utility of space. When main propulsion is not in use, the hydraulic power can be used for other requirements on the boat such as operating winches and capstans, or raising or lowering ramps as on landing craft, all of which would use fluid motors.

The 1000 hp experimental drive was built for a switcher locomotive, providing for twenty-one steps of speed control as compared with eight steps of control on electrical drives. Railroad motive power superintendents will recognize the advantage of having sealed self-lubricated traction motors without the maintenance of commutators and bearings. Preliminary investigation indicates that the first cost should be comparable to electrical drives, so that the savings in maintenance costs would accrue to the credit of the operating department.

It has now become obvious that hydrodynamic hydraulics, as applied to many diverse industrial installations, is here to stay.

Because the modern concept of hydraulic design incorporates such important features as simplicity, ease of control, diversity of application, remote controllability, high torque, variable speed, long life and low maintenance, it is generally believed that the hydraulic manufacturing industry is on the threshold of its greatest period of growth. As we have had in the past a mechanical era and an electrical era, we are now entering what will be known as the hydraulic era.

OPERATING AND ECONOMIC ASPECTS *of* HIGH SPEED TANDEM COLD REDUCTION MILLS

By F. K. SCHEFE
Flat Products Engineer
United States Steel Co.
Pittsburgh, Pa.

. . . . mill speeds have increased to the point where minor delays can greatly affect available mill production . . . . well planned operation can increase mill efficiencies . . . .

▲ SINCE the closing months of 1945, there has been an almost insatiable demand for flat rolled products. This demand had its origin in the curtailment during the war years of production of a large proportion of items made from sheets and tin plate, both necessities and conveniences. The steel industry, in 1945, was abruptly handed the task of supplying the enormous quantities of flat rolled products needed for replacement of worn-out automobiles, for new refrigerators and furniture, for newly popularized deep-freezers and television; and therefore, all flat product facilities, including cold reduction tandem mills, were promptly placed on a maximum production basis. The flat-products industry entered the post-war high demand period with, in most cases, the same facilities as were available before the war started. To meet the new demand, each company proceeded to increase its capacity by installing additional mills or by improving existing facilities. Increasing the operating speed and improving the performance of existing mills offered one effective method of increasing output, and new mills, designed to operate at much higher speeds than were common before the war, gave a second method.

The speed of the initial 3-stand and 4-stand mills, installed in the early 1930's, was about 220 fpm and that of the 5-stands about 550 fpm. A great amount of development work was required to make those speeds practical. Breakdowns of reels, drives and guides were a daily occurrence; electrical controls were crude as measured by today's standards and inclined to be highly temperamental; strip lubrication and roll cooling were mysteries. There were many defects in coils. The know-how for detecting, analyzing and correcting troubles did not exist. But these problems were partly corrected, circumvented, or minimized, and by 1941, 3-stand mills were built to operate at 950 fpm, 4-stands at 2600 fpm, and 5-stands up to 3750 fpm. This speed increase was gradual over the years, ordinarily with each mill built to operate somewhat faster than its predecessor, and built with the knowledge that considerable further development work would be required before the top speed could be effectively utilized. Since 1946, new mills have been installed and old ones rebuilt with 3-stand speeds up to 1600 fpm, 4-stand at 3500 fpm, and 5-stand at 6000 fpm. Faster speeds are contemplated for mills now being planned and constructed.

Coincidental with increase in speed has been an increase in rate of production. The first 5-stand mills were rated by mill builders and operators as having a capacity of 100 tons per 8-hr turn; today 5-stands are producing 500 to 600 tons per turn regularly. A 3-stand mill that averaged 350 tons per turn before modernizing at 500 fpm, today has a monthly record of 838 tons per turn operating at a speed up to 1200 fpm. From these figures it must not be inferred that the tonnage increase is all due to higher speeds; many other factors contribute. There are still many operating problems which require considerable attention before maximum utilization of available and planned speeds can be realized.

For purposes of comparison, the effectiveness with which speed is being utilized can be expressed in terms of per cent efficiency. For example, a 3-stand mill, operating at 100 per cent efficiency at 1200 fpm for 8 continuous hours, rolling a strip 43 in. wide to 0.047 in. finish gage, could produce 575,000 ft or 2060 tons of product. In actual practice, a mill operating with an average product as used in the example and with the top speed potential indicated, has a monthly record average of 838 tons per 8 hours, indicating that the mill is operating at 41 per cent of theoretical capacity. Over 50 per cent of the theoretical capacity is lost. Less than 600 fpm of available speed, if used at 100 per cent efficiency, would be needed for production. The other 600 fpm is provided to make up losses. A 5-stand tandem mill with a top operating speed of 6000 fpm has a theoretical capacity for rolling 2,880,000 ft of strip per

8-hr turn; it has actually produced at average rates up to 1,200,000 ft per turn, or at an efficiency of 42 per cent. Another 5-stand mill with top speed of about 3900 fpm is producing at about 59 per cent of theoretical capacity.

The 100 per cent efficiency figure when applied to mills, is idealistic to say the least, and not attainable under present conditions of operation and design, but it does serve as a yardstick between comparable units. As an indication of how closely the 100 per cent is attainable in some operations, a number of electrolytic tinning lines are currently operating at well above 90 per cent efficiency.

Why should 40 per cent or more of potentially available capacity not be realized? The answer may be found principally in design and operating problems that cause loss of production, and with that loss, also high costs and inferior quality. The remedies for the problems are not in many cases immediately available, but a brief diagnosis may help lead toward solutions. For purposes of quick evaluation, these problems which prevent efficient utilization of speeds now available, may be grouped into a few main classes: (1) problems that are indicated by clearly defined delays of the type recorded on daily operating reports, (2) problems that cause steady loss of production but are often accepted as part of normal operations, and (3) those problems that intermittently cause production losses, or are conducive to poor mill performance.

Delays of the recorded type vary widely in cause and duration, but will ordinarily not be less than 40 min and may be as much as 120 min or more per turn of 8 hours. If we assumed the average to be 70 min, one-seventh of the operating turn would be lost.

Probably the greatest single cause of this lost operating time is in roll changes, with normal expectancy of not less than 2 per turn and possibly as many as 6 or 8. The number of roll changes required is determined by normal wear, by the number of width cycles employed and by accidental roll damage. Each roll change on a wide mill now requires up to 15 to 20 min of actual mill downtime, on a narrower mill from 5 to 15 min. In addition to the tonnage lost while the mill is down, a considerable amount of slow speed operation may be required after a roll change while the mill is being warmed up and shape restored. Many of the changes cannot be avoided, but by careful production planning, the number of width cycles can be held to the minimum conducive to good order performance. Damage can be held to a minimum both in volume and severity by careful operation of the mills, by adequate lubrication and by improved quality of incoming strip. The downtime could be materially reduced on most present mills with faster screwdowns, better roll handling, and improved means for coupling up and clamping. This has been demonstrated on one 5-stand mill which is equipped with Ward-Leonard operation of screwdown motors to provide rapid free travel of the screws without sacrificing power and accuracy when the mill must be adjusted under load.

A second delay problem and major source of production loss is the necessity for frequent width changes with the type hold-downs normally used. With each new ordered width, hold-down boards must be removed, side guides reset and hold-down boards reinserted. In some plants these changes may be required 15 to 20 times in a turn, with each change taking from 2 to 5 min. The incidence of guide changes is dependent upon the type and size of orders received, but careful production planning and mill scheduling can do much to reduce the number. This is extremely important from the standpoints of quality and yield as well as production, as with each width and gage change, the mill tends to cool off and must be reset, with consequent poor shape and gage until heat is regained and the optimum setting found. Also, the metal bars used for side guides wear rapidly and cause pick-up, rolled-in particles and damage to the strip edges; and hold-down boards accumulate steel slivers which scratch the strip surface and must be replaced after a few hours of operation. The development of an automatically adjustable, fully mechanical side guide and hold-down would appreciably contribute toward reduced mill operating costs and increased mill utilization.

A third operating problem which causes delays and prevents maximum production, particularly on mills rolling the lighter gages, is strip breakage. Breakage may be due to the characteristics of the incoming strip, incorrect rolling practices, unresponsive mill controls, faulty lubrication, or to other causes. Whatever the cause, the result is loss in yield and lost time while removing the scrap. In addition, rolls are frequently damaged by the broken strip and must be changed. With mills running up to 5000 fpm, 100 to 400 ft of strip is fed out of the mill before it can be stopped, and much of this strip will cobble into guides and be wrapped around back-up rolls and other mill parts. Strip breakage at high speed can also cause broken rolls and damage to spindles and other mill parts. On a good turn, the strip will break only two or three times, on a bad one there may be as many as 20. Each break will cause from one to three minutes lost time. For partial remedy, cobble guards have been installed on several mills to prevent the strip from passing between the backing-up and work rolls; specially designed strippers are used to deflect the strip and permit easier removal of broken ends. After a break occurs, it is often extremely difficult to determine the cause, but continual breakage indicates that corrective measures are needed some-

Figure 1 — This modern 4-stand tandem mill has a rated speed of 3000 fpm.

where in the production process. To reduce the number of breaks, many plants are now side trimming coils before cold reducing, thus eliminating or reducing the problems of width variation, crooked head and tail ends, and cracked edges.

Mechanical and electrical delays on tandem mills, once a major problem, have been reduced to the point where 20 minutes per turn is considered cause for serious concern, and 10 minutes or less is commonly attainable. Mills today are rigidly built to stand the service normally experienced. Continuous improvements have weeded out many of the weak spots that formerly caused delays. This does not mean that breakdowns no longer occur. They still do, but their frequency has been very much reduced. A great deal of credit for reduced outage time should be given to maintenance personnel. Skilled mechanics and electricians, developed over the years, are able to keep the mill running under adverse conditions, make quick temporary repairs, and detect incipient breakdowns so that preventive maintenance can be done during the weekly shut-down turn.

Elimination of recorded delays of the type listed would provide a theoretical 14 per cent increase in capacity. Obviously realization of the full 14 per cent is impossible, as items like roll changes are an integral part of mill operation. However 14 per cent is a large number to aim at, and even partial attainment would appreciably increase the efficiency of high speed units.

The second major group of problems that are a source of capacity loss on modern high speed mill units is the type reflected by the unrecorded delays that occur, generally between coils. The mill may be idled for a minute or more for various reasons; threading the mill, accelerating, decelerating and running at threading speed, are all operations that are carried on at very low efficiencies. With coils weighing 10 tons, 50 such low efficiency periods occur during each 500-ton turn. If the time lost between coils were as much as only one minute average, 50 min would be lost per turn. Theoretically, the only time that should be lost between coils is the time required to strip a coil from the reel, re-engage the belt wrapper, and start the following strip onto the reel, plus the time of acceleration and deceleration, a total of 20 to 30 seconds. It is probable that the one minute interval is more common on most mills.

Operating problems at threading speed are of limitless number. Considerable hard labor is required to break down and straighten the coil ends and to enter them into number one stand. The ends of the strip must be carried and guided manually from stand to stand. The act of sticking each mill is a high precision operation. Because of the manual nature of the threading operation, threading speeds are usually held to 150 to 300 fpm, or as fast as a man can safely and effectively direct the strip. Strip run at threading speed is usually off-gage. Delays are frequent because of crooked head and tail ends, inaccurate sticking, and coils temporarily hung-up on reels.

In order to hold the threading speed at a maximum for the longest possible time, some mills have been equipped with two steps of threading speed, the faster used while the tail end is clearing the mill and the following head end being fed into the entry stands, the slower while the head end is being fed through the finishing stands and onto the reel. This is helpful, but requires added coordination of the mill crew. A more effective solution would be provided by an automatic threading device that would not prohibit access to the mill and would at the same time permit threading at high speeds.

Large coils, the largest that can be handled at the mill and in other processes, are essential for reducing delays between coils and for maintaining the mill at top speed the maximum possible percentage of the time. Doubling the size of 6000-lb coils potentially adds almost 30 per cent to capacity of a 1000 fpm sheet mill. Doubling the size again to 24,000 lb could add another 15 per cent. And in addition to increasing the tons rolled, more of the tons would be to specified gage. In a 6000-lb coil of 0.040 gage, at least 50 ft total at the ends will be off-gage. This is 5 per cent of the coil. Doubling the coil size would reduce the heavy ends to 2½ per cent; doubling the coil size again to 24,000 lb would indicate a theoretical reduction to 1¼ per cent. This potential reduction is not as yet being fully realized where large coils are available because of handling difficulties, weld breakage and off-gage sheets at the welds, but the possibilities of approaching such reductions have definitely been established.

In some plants, as many as six small coils are welded together to provide coils weighing from 30,000 to 70,000 lb. Where possible, coils weighing up to 20,000 lb are produced on the hot strip mills, thus reducing the number of welds required. Welding technique and welding equipment have been greatly improved, and weld breakage on sheet mills is reported to average 2 per cent or less over extended periods. Though weld breakage in light gage tin plate coils is somewhat greater, welding is still considered economically desirable because of the increased capacity and higher yield obtainable, particularly when the hot strip coil size is limited to 6000 lb or less. A 6000 lb, 42-in. wide coil reduced to 0.036 gage would be about 1140 ft long. With a 1500-fpm mill, less than a minute would be required to roll the complete coil. The difficulties attendant to handling the coils to the mill, preparing the ends for entry into the mill, threading, and stripping 6000-lb coils from the reel at the rate of nearly one per minute are obvious. The production rates being obtained today on high speed mills would not be realized without the added provision of

Figure 2 — Delivery end of a modern 4-unit continuous pickling department.

large coils. As a further consideration, it may even very well be that we have arrived at the period where it will be practical to provide continuous high speed rolling on tandem mills by installing welders directly in line with the mills.

Earlier in this discussion, an example was given illustrating the requirements for a mill to produce at 100 per cent of theoretical speed capacity. Higher speed mills are actually producing at approximately half this rate, others are operating at 40 per cent, a few may for short periods reach 60 per cent. As has been discussed, possibly 14 per cent of the loss in efficiency may be ascribed to recorded downtime, possibly an additional 10 per cent to slow speed operation and an accumulation of minor delays during threading. Possibly 5 to 10 per cent is always allowed at the top of the range for speed regulation. The balance of the indicated production loss is due to the fact that normal operating rate is 75 per cent or less of theoretical top speed, partially because of problems such as strip lubrication, inadequate power, mill cooling, chatter, pick-up, and strip shape. Some of the slower speed rolling is planned, as during the rolling of special types of steel which the operators know has a tendency to break; some is due to inadequate knowledge of rolling technique. Probably more than we appreciate is due to problems of quality at high speed. At speeds over 1500 fpm, the moving strip looks like a shining streak of metal. It is very difficult to distinguish a bruise mark or any other spot imperfection, and with a large coil, a considerable amount of reject material may be rolled before the defect is detected and corrected.

Figure 3 — Delivery end of a modern electrolytic tinning line.

Strip lubrication and roll cooling are problems that have caused serious concern ever since the advent of the cold reduction process. As the production of a mill is increased, either by improved utilization or by increased speed, with corresponding additional heat generation, these problems become more acute. At present production rates, and with speeds up to 2000 fpm, current methods of lubrication and cooling, particularly for the heavier gage sheet products, appear reasonably adequate. At speeds above 3000 fpm, obtaining sufficient cooling, controlled accurately enough to maintain good roll and strip shape, and obtaining lubrication which will avoid pick-up and mill overloading and at the same time avoid looping between stands, becomes more difficult. In some instances, cooling has been greatly improved by the use of higher pressures, greater volumes and better designed and located spray headers and nozzles. At the higher speeds, it is also more difficult to keep the mill clean and to avoid splashing and lubricant carry-over on the finished strip. The cost of the strip lubricant varies from about 10 cents per ton on the wider sheet mills using standard rolling oils, to as high as $1.80 per ton on 5-stand tin plate mills where from 2 to 10 lb of palm oil, costing 18.5 cents per lb in January, 1951, are used. Where palm oil is the principal lubricant, premixing of the oil with water has been beneficial in reducing the amount used. However, extreme care must be used in designing the distribution system, as the oil has a tendency to separate from the water, and thus cause variable amounts of lubrication with disastrous results at high speed.

A problem of great concern is the quality of the hot-rolled coils. Overpickling, scale patches, holes, over or under width, off-gage, excessive hardness, and damaged or cracked edges cause strip breaks, mill damage, and slow rolling, with resultant low production, poor quality, and high costs. These defects are normally concealed in the coil, and considerable trouble may be caused before their existence is detected. Troubles from this source multiply as the speed of the mill is increased. Correction of the difficulties requires constant inspection and attention during the pouring of the steel, rolling of the slabs, and rolling and pickling of the hot strip.

A great portion of the preceding discussion has consisted principally of listing some of the more common types of tandem mill operating and design problems, and illustrating their effect on the efficiency at which mill speeds are being utilized. In addition to considering the possibility of minimizing some of these problems in order to determine the speed for which a mill should be constructed, it is necessary from the economics standpoint to analyze customer demands to determine the amount and type of capacity required, the investment needed, overall cost of operation, and sales proceeds. As the installation will probably have a life expectancy of twenty years or more, consideration must be given to market trends, possible future equipment developments, effect of taxes and national policies.

The market demand for flat rolled products is currently at a high level. Many new uses for flat rolled products are being developed; the number of potential customers for items made from flat rolled products is constantly increasing. It therefore appears that if no substantial change is made in our national economy, the demand for sheets and tin plate will continue to grow,

indicating that similar capacity growth is desirable.

To effect that capacity growth, substantial investments are required. Annual depreciation, interest, and taxes on the investment are an integral part of the total cost of each ton rolled. The investment must therefore be held at a minimum figure compatible with low day-to-day normal operating costs. A complete mill unit including buildings, mechanical equipment, electrical equipment, foundations, and the work of installation, may cost from $3,000,000 to $10,000,000 depending upon the type unit and auxiliaries involved. On a 20-year basis, amortization of this investment alone will cost $150,000 to $500,000 annually.

As mill speed is increased, investment costs likewise increase. With the high speed unit, mechanical equipment, including uncoilers, mill stands, recoilers and auxiliaries will usually be somewhat heavier and larger. The size of motors and drive mechanisms increase; more extensive fog exhaust systems are needed; more sensitive controls and more automatic and remote control features are required; special low inertia tandem motors and low inertia speed increasing gearing become more necessary. Non-contact gages of the x-ray type are indicated for the higher speeds.

As an indication of the investment increase required as mill speed is increased and horsepower raised in equitable proportions, the following rough estimates of the costs of main drive electrical equipment are presented: for a 5-stand mill at 4000 fpm $2,225,000, at 5000 fpm $2,390,000, at 6000 fpm $2,860,000, at 7000 fpm $3,180,000. For a 4-stand mill at 2000 fpm $1,355,000, at 2750 fpm $1,800,000, at 3500 fpm $2,190,000. For a 3-stand mill at 1000 fpm $830,000, at 1500 fpm $1,135,000, at 2000 fpm $1,660,000.

A Ward-Leonard type screwdown will cost approximately $31,000 more per stand on a 5-stand mill than will a conventional screwdown. These cost estimates are for comparative purposes only, for mills doing the same job at various speeds.

To compensate for the added investment costs for a high speed mill, operating costs must be reduced. Analysis of the major items that make up normal operating costs indicates that the cost of maintenance and repairs will vary partly on a per ton rolled basis and partly on a daily basis, thus decreasing this item of cost to some extent on a more productive unit; that costs of lubrication, operating supplies and the like should remain fairly constant at a definite cost per ton rolled, and that fixed charges as for general expense and supervision should remain constant at a definite cost per day or month. Yield should be about the same for high speed and lower speed units, with possibly a slight advantage in favor of the lower speed mill.

Sales proceeds will be the same per ton, regardless of whether the product is rolled on a high speed or a slow speed mill. Justification for the greater investment costs of the high speed unit is therefore dependent upon selling more product, or producing it at lower operating cost.

This discussion of the economics of increasing mill speeds has been on a general basis because of the very wide range of variables existing from plant to plant and even in the same plant in regard to investment, operating conditions and company policies. However, under a given set of conditions, reasonably close estimates can be made of economical speeds, and will ordinarily prove that the higher speeds are justifiable to the maximum value at which the speeds will be used efficiently.

Discussion of all of these problems indicates that a stage in mill development has been reached where speeds available are not as yet being used to full advantage. It is reasonably certain, however, now that the speed is available, that rolling knowledge will be increased, and more of the speed currently built into mills will be utilized. Faster speeds will require further development work, and may bring problems that present designs, construction and operating methods may not solve. Regardless of the problems involved, it is certain that engineers and operators will continue to raise speeds to as high a point as the laws of nature and economics will allow.

Figure 4 — Entry end of a modern continuous annealing furnace for strip for tin plate.

DISCUSSION

PRESENTED BY

ALFRED KRAUSE, General Superintendent Rolling Mills, Ford Motor Co., Dearborn, Mich.

F. K. SCHEFE, Flat Products Engineer, United States Steel Co., Pittsburgh, Pa.

ROBERT SERGESON, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

JOSEPH S. HORVATH, Superintendent, Ford Motor Co., Dearborn, Mich.

W. C. McCONNELL, JR., Reliance Electric & Engineering Co., Detroit, Mich.

C. BOWEN, Steel Division, Rouge Plant, Rolling Mill Maintenance, Ford Motor Co., Dearborn, Mich.

Alfred Krause: How fast can we expect to stop a mill running at 1700 fpm?

F. K. Schefe: I would judge that in an emergency stop, four seconds; on a normal stop, six seconds.

Robert Sergeson: What happens when the butt-weld goes through a high speed mill?

F. K. Schefe: The welds are normally made by the flash method. After the weld is made, excess metal is removed by a flash-trimmer. In some plants, a little excess metal is left at the weld. In others, the weld is undercut slightly. Both methods have some good and bad results.

The trimmed welds are taken through the mills as they leave the pickling lines, and more and more they are being taken through at high speeds. For a long time, the tendency was to slow down at the weld, to creep through with it so that you do not damage the rolls, but recently the tendency is to keep the mill wide open.

Weld breakage depends upon many factors. With good welds, good steel and a good mill set-up, breakage may be only occasional. If conditions are not right, breakage may run 30 per cent or more.

Alfred Krause: If you go to speeds higher than 7000 fpm, is it not going to be necessary to drive the back up roll?

F. K. Schefe: It might be.

Alfred Krause: Your contact is so small there, that you do not have any friction.

F. K. Schefe: I do not believe too much is known at present about driving backing up rolls at high speeds. We may get into problems that tend to block the high speed objective.

Joseph S. Horvath: Is automatic control being used?

F. K. Schefe: Not to any great extent so far as I know. Automatic tension controls have been tried experimentally, but as yet, most operators are satisfied to have "indication," rather than automatic control.

W. C. McConnell: How much life can you expect out of your backing up rolls?

F. K. Schefe: The life of the backing up rolls, barring accidental damage, is normally a function of tonnage rolled. Ordinarily once a week a general roll change is indicated and I think that most mills find that they last that long without causing too much trouble. The initial stands may go longer than that — say two or even three weeks, but for the final stands a change once a week is advisable.

Member: At the higher speeds, larger electrical equipment and more kwhr are required. Do you consider the increased power consumption a definite cost factor?

F. K. Schefe: If the power is being used at very nearly the same relative efficiency as at the slower speeds, with tonnage increase proportionate to the larger electrical equipment, cost should not vary appreciably per ton of product rolled.

C. Bowen: How are the bearings and backing ups and work rolls standing up in comparison with the fast speeds or the slow speeds?

F. K. Schefe: At first, there was a lot of trouble with bearings. On some of the mills it was found necessary to increase clearance both in the backing up and work roll bearings over what normally had been used. With experience and minor corrections, most of the troubles have been eliminated. In starting up a new mill with tight bearings, a great deal of trouble can be experienced at the higher speeds.

Plan to Attend

1952 ANNUAL AISE CONVENTION

AND

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2 AND 3

AN INTRODUCTION TO CLAD METALS

By WALTER L. KEENE
Director of Research
Superior Steel Corp.
Carnegie, Pa.

. . . . with cladding, advantage may be taken of the beneficial properties of various metals, at the same time maintaining economy . . . .

▲ BECAUSE modern civilization depends so greatly on metals, it is fortunate there are many different kinds available, each possessing certain useful properties, but by the same token having certain limitations. Some are ductile and tough, some are hard and strong, some are light, some heavy, some resist various corrosive agents, some have useful thermal, electrical or magnetic properties and so on through the list.

Unfortunately, however, no one metal combines all the virtues required by some applications or some designers. In addition, some of our most useful metals have always been and are becoming even less abundant, or are extremely difficult to win from their ores, and hence, are too costly to use freely.

Throughout all recorded history, the problem has arisen of obtaining several different properties in a metal which are not inherent to it, and has been solved with some degree of success in two ways—by "alloying" and by "combining."

While "alloying" is an excellent method of obtaining unusual properties in a metal, it, per se, is not within the scope of this discussion. "Combining," in making use not only of the prime metals but of their alloys as well, has accomplished three tremendously important results. Combined metals and alloys have: (1) approached perfection in meeting unusual requirements; (2) effected economies in costs; and (3) enabled the conservation of scarce or critical metals.

The above order changes with the times. Economy, which is related in some instances to scarcity, is probably the oldest reason for combining metals. The jewelers art is a prime example of this. In times of peace, the approach to perfection in properties is of vital interest to engineers and consumers alike. In times of stress, however, the conservation factor comes to the fore.

Some few metals must sometimes be used in their purest state. Unfortunately these metals, for example, copper, chromium, nickel and others, are not exactly abundant. Obviously, for applications wherein certain properties of these metals are required but others are not, available supplies can be stretched out enormously by "combining" with more abundant metals and alloys.

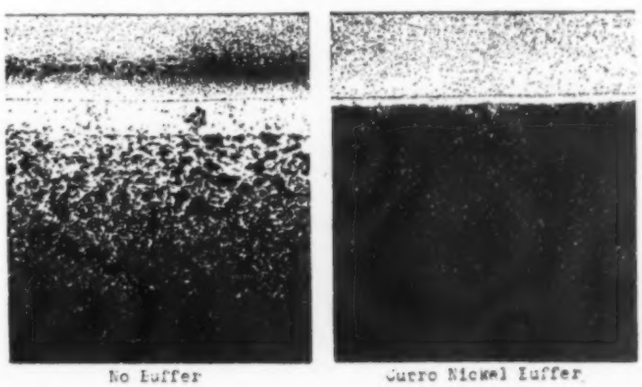
WHAT ARE "CLAD" METALS?

The term "combined" metals encompasses an extremely broad field. As it is manifestly impossible to cover this field in one discussion, it is necessary to narrow down and focus on one phase and this may best be done by the use of definitions.

"Combined" metals might well include "composite" metals and "clothed" metals. Composite metals are defined as those which consist of two or more metallic components, the smallest being at least 3 per cent of the total. A composite metal does not necessarily have the second component at a surface.

"Clothed" metals are those which consist of two or more components, usually arranged in distinct layers,

Figure 1 — Carbon migration is controlled by use of buffers between the components. On left is shown straight chrome stainless on top bonded to 0.80 C steel on bottom. On right is shown the same materials with a cupro-nickel layer between the components.



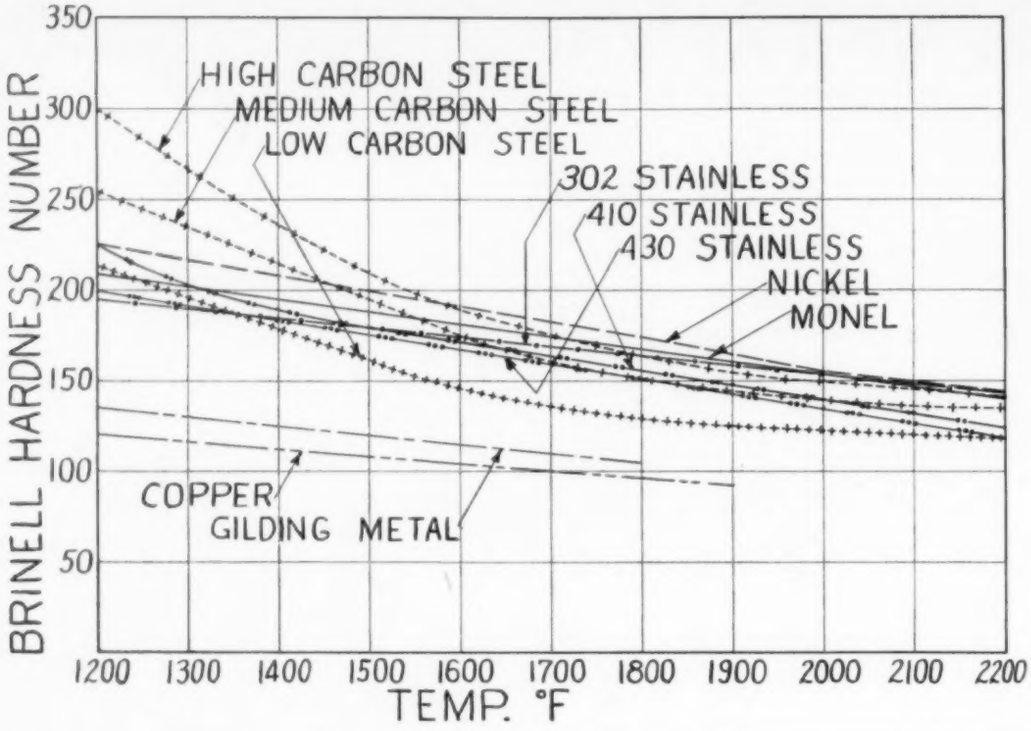


Figure 2 — Chart shows hardness vs temperature for various components used in clad metals.

with the metal having the lesser thickness generally being at a surface. In this category, there are two subclasses; "coated" and "clad."

Coated metals might best be defined by illustration. Included in this classification are the following: electroplated metals; hot dip coated; sprayed, without further work; faced-by-welding, without further work; impregnated, as chromized or siliconized; and coated by methods as sherardizing, calorizing and the like. In most cases, the surface layer is less than 3 per cent of the total mass.

In an attempt to bring some order into this somewhat chaotic situation, an arbitrary definition of "clad" metals brings into consideration the method of manufacture.

"Clad" metals are those which consist of two or more metallic components, the smallest being at least 3 per cent of the total mass, the components being arranged in layers with the smallest generally at a surface, inseparably bonded in a rolled product. This definition should not be interpreted to mean that clad metals must necessarily be produced by rolling alone, it means that rolling is generally one of the operations used to produce the finished clad metal.

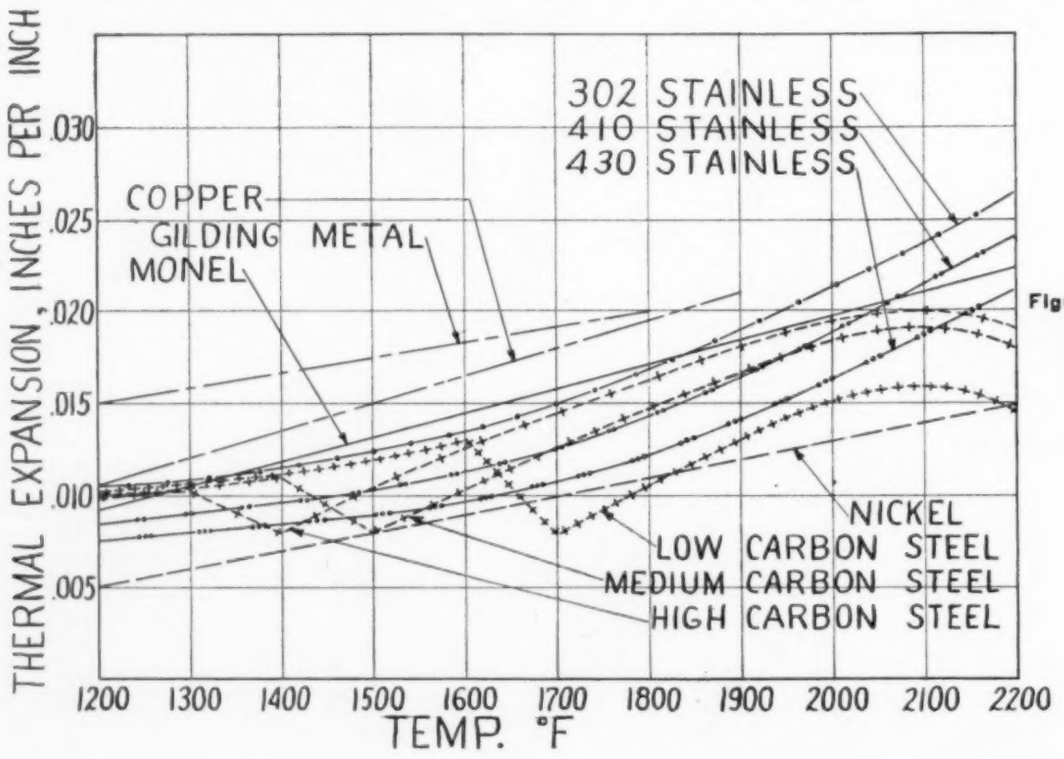


Figure 3 — Chart shows thermal expansion for various components used in clad metals.

CHARACTERISTICS OF CLAD METALS

One of the most favorable characteristics of clad metals is that, when properly made, the layers cannot be physically separated. When compatible metals are properly bonded together, and, of course, are inherently ductile, they can be drawn, rolled, spun, bent, twisted, heated and quenched, upset, punched or otherwise formed as though they were a solid metal, providing also, that proper precautions have been taken to insure ductility at the bond line.

Regarding this latter point, certain elements, commonly found in the components of clad metals, will interact with each other at elevated temperatures, provided the time factor is present, to form brittle compounds. An excellent example of these interacting elements is carbon and chromium. When chromium containing alloys, as the straight chrome stainless types, are bonded to steel, chromium appears to draw the carbon of the steel across the interface and concentrate it adjacent to the interface in the chromium containing component, forming a high carbon-chromium alloy that, after ordinary annealing treatments, is hard and brittle. Unless this action is prevented, such clad metals cannot be deformed with the chromium-containing layer flaking off in brittle fashion. This migration is illustrated in Figure 1 which shows at the left, a straight chromium stainless steel, at top, bonded to an 0.80 per cent carbon steel, below, without a carbon-stopping layer between the components; and at the right, the same components but with a thin layer of cupro-nickel interposed prior to the hot rolling-bonding operation. Note the depletion of carbon from the carbon steel below the interface and its concentration above on the left hand sample and the sharp line of demarcation between the components in the right hand sample. The cupro-nickel layer has prevented carbon migration and this right hand material is ductile.

The properties of clad metals can almost be tailor-made. They can be designed for specific corrosion resistance with great strength, specific corrosion resistance with excellent thermal conductivity; oxidation resistance; bearing properties with high strength; damping characteristics; shock resistance; and other desirable properties. By cladding, advantage can be taken of only the better properties of the several different metals.

The surface of clad metals is solid, non-porous and homogeneous, having all of the characteristics of the solid metal of which it is composed. The core metal is likewise in its best condition for the service intended; that is, annealed or heat treated.

PRINCIPLES OF BONDING

There are many factors involved in the successful bonding of dissimilar metals, but two are considered of prime importance — heat and pressure. While it is possible to bond some metals to other metals by merely hammering (or rolling) them together at room temperature, the use of high temperatures is almost mandatory in modern practice. High temperature first lowers the compressive strength of the metals so that they conform to each other more readily, then aids by increasing atomic-mobility and promoting migration.

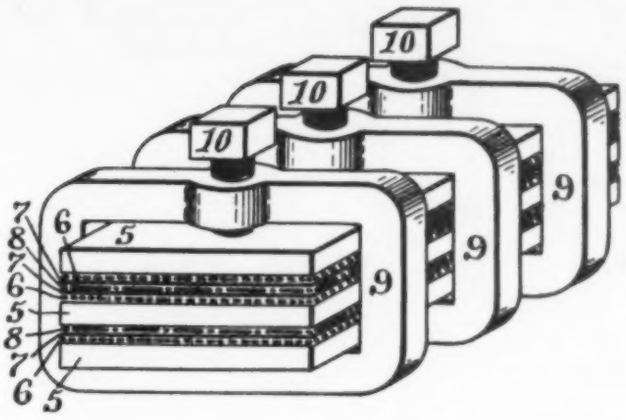


Figure 4 — Illustrated is one of the oldest methods of bonding dissimilar metals.

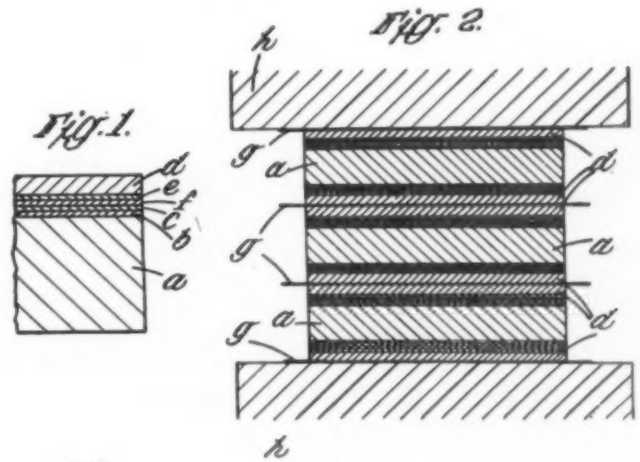
Pressure is used to bring the dissimilar metals, softened by heat, into close contact so that diffusion can take place more readily.

Another factor used in most modern processes of cladding is movement. It is one of the fundamentals that clean surfaces be placed face to face during assembly, but in spite of all precautions, there sometimes exists a thin oxide layer on one of the metals and this oxide, even though invisible, can effectively prevent bonding. Movement then aids by breaking up this barrier. In rolling, for example, the oxide is stretched, thinned and broken, thus exposing islands of clean metal to which the other metal "seizes."

It is not only necessary to start with clean surfaces, it is necessary to maintain this cleanliness. This is accomplished in several ways — some producers acid pickle and immediately electroplate (or otherwise coat one or both of the components) with a metal whose oxide is not hard, adherent and continuous; other producers seal the assembly air-tight, as by welding, so that air cannot get between the contacting faces of the metals during heating for rolling.

Another factor in bonding is degree of compatibility. Steel, for instance, generally hot rolls best at temperatures above about 1600 F; aluminum on the other hand, melts at about 1200 F. Obviously, such a combination

Figure 5 — Shown is a pressing method of cladding (patented by S. Deutsch).



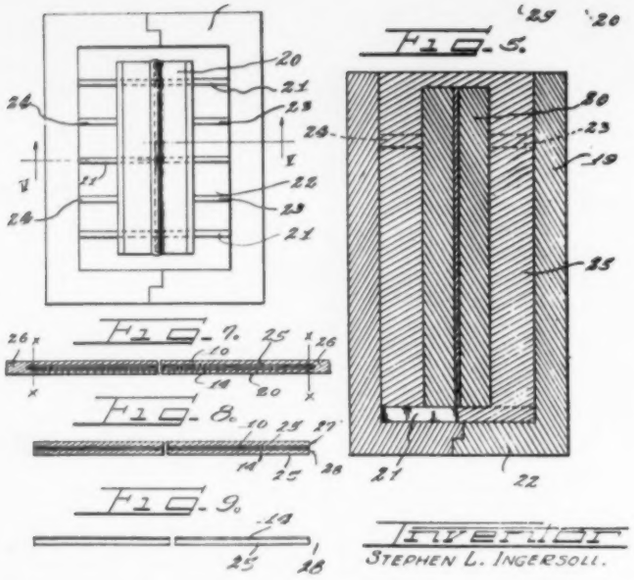


Figure 6 — Sketch shows one of the casting methods for cladding metals (patented by S. L. Ingersoll).

is non-compatible and the hot rolling-cladding method is not generally used. Some metals cannot be hot rolled at all — they are "hot-short," as for instance, the lead containing, copper-base bearing-metal mixtures. In these cases, methods other than the hot rolling together of solid slabs of each metal must be used.

Alloys containing aluminum, chromium or silicon usually form a tough, hard, adherent, continuous oxide on their surface when exposed to air. Special techniques must be used when cladding these alloys to other metals, else a good bond will not be obtained.

There are many other factors to be considered in the cladding of metals which can be realized by studying the innumerable methods of cladding which have been developed, and as it is impractical to discuss all of these factors, two more will be mentioned here; that is, hot hardness, a measure of plasticity at elevated temperature; and thermal expansion.

One of the nuisance features encountered in clad metal work is the difference in plasticity between the components of a clad assembly when at proper rolling temperature, which latter, of course, depends on softening point, melting point or other critical characteristics of the metals. An example of this is copper clad to steel. The temperature used is, in this case, around 1700 F, at which temperature, copper is soft and mushy and steel is quite stiff and resistant to deformation. Before bonding takes place at the interface, the copper elongates at a greater rate than the steel and thins out, running off the ends of the slab. Such behavior must be forseen and corrections made.

In Figure 2 is shown arbitrary Brinell type hardness values for various metals used in clad metal work versus temperature in the range 1200–2200 F. These values were obtained by dropping a known weight carrying a Brinell ball a fixed distance onto a heated sample, then measuring the impression and calculating a hardness number from the various factors involved. The numbers, being arbitrary, are useful only as a means of comparing the hot plasticity of the various metals. It can be seen that nickel, monel, and three types of stainless steel have hardness values similar to those of medium and high carbon steel at the temperatures shown, while low carbon steel is somewhat softer. Copper and a copper-zinc alloy are somewhat softer than low carbon steel and considerably softer than the other metals and alloys diagrammed.

Not only do such curves indicate the degree of compatibility, but they can serve as a basis for determining the relative starting thickness of the several components of an assembly. Before bonding takes place in hot rolling, the harder materials will tend to maintain their original thickness at the expense of the softer material; therefore materials with high hot-hardness values can be thinner, originally, then the low value materials. Conversely, when cladding a soft material to a harder one, a thickness percentage wise, greater than the desired finished thickness must be used. Sometimes the difference in hot hardness or plasticity is so great be-

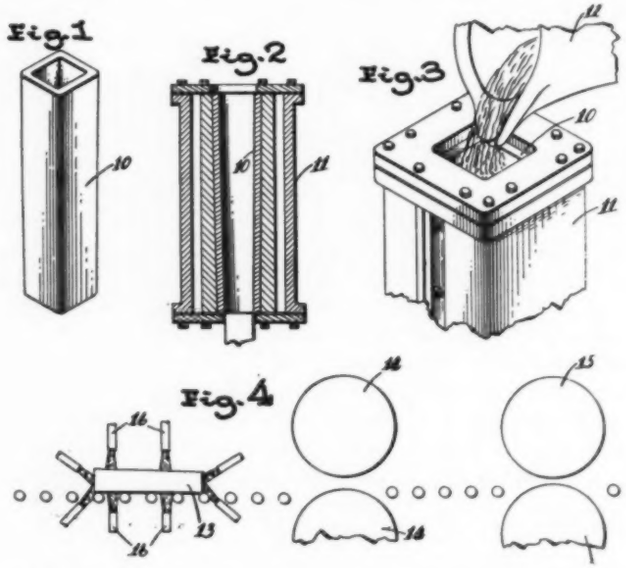


Figure 7 — This casting method is used in the production of copper clad bars and wire (patented by P. Cykajlo).

tween components that it is impractical to attempt to bond them by direct hot rolling. In such cases, a prior pressing operation is useful to form a bond, for once a bond is formed then the different metals behave more like a solid element, the one metal carrying the other along, so to speak.

Thermal expansion of the several components is an important factor in some cladding methods, especially direct hot rolling. In some copper clad steel assemblies for example, the copper is fastened to the surfaces of the steel slab and held mechanically in place. During heating for rolling, the heat of the furnace strikes the copper surface first. Not only does copper have a higher inherent thermal expansion coefficient than steel, but it gets hotter faster and expands in every direction. This complicates the holding together problem.

In Figure 3 is shown actual thermal expansion vs temperature for several of the commonly used clad metal components. These values were obtained by heating pre-measured samples from room temperature to the temperatures indicated and measuring them while

hot. The figure shows not only the great expansibility of copper and a copper alloy, but the effect of the critical temperature of steel. It is easy to imagine the pulling and hauling that goes on during the heating of mechanically fastened assemblies of different metals. Experience has shown that certain area or width limitations exist in mechanically fastened or direct-welded assemblies which, if exceeded, will certainly cause the assemblies to come apart during heating due to these differences in expansion characteristics.

METHODS OF CLADDING

More than twenty different methods of cladding have been developed, and are described in U. S. patents. Some of these have been brought to commercial status and are used to produce considerable tonnages of clad metals, some have gone no further than the idea stage.

In general, there are five systems in use today; pressing, casting, direct rolling, sintering and deposition. There are many variations in each class, many modifications, many improvements to basic ideas. Some are even on the borderline of the clad metal definition, but if a rolling step is included in the manufacturing operations, they are being included in this discussion.

In order to illustrate, in a general way, the various cladding methods, figures from various patents have been selected which show the essentials of a process. These illustrations do not, in most cases, show all the steps involved nor the end product, being used merely to show the starting point or the general arrangement

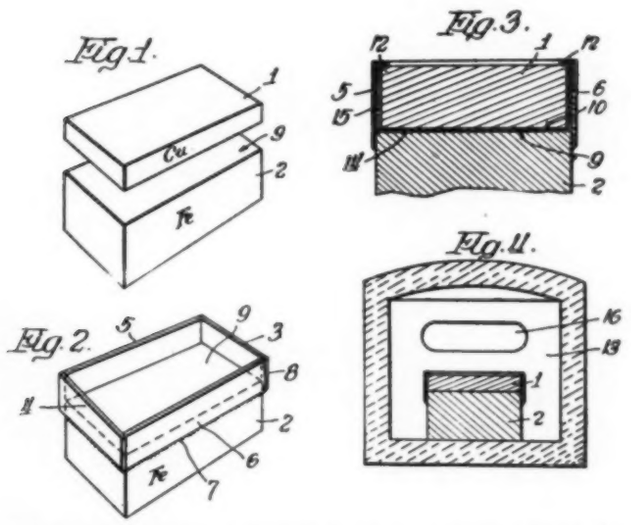


Figure 8 — Method patented by T. B. Chace for cladding metals.

of components or apparatus used. As it would be impossible to even mention here the more than two hundred patents issued on clad metals, it should be understood that the figures were not selected "with malice aforethought" nor with any ulterior motives. They were chosen merely to illustrate a general method. It would be nice to be able to give credit to all of the workers in this field here but such would be out of place in a discussion of this kind.

PRESSING METHODS

Figure 4 illustrates one of the oldest methods of bonding dissimilar metals. Here is shown a multi-layered pack, held together with clamps. This whole assembly is placed in a furnace, heated to a temperature suitable for either softening the solder between layers of metal, if solder is used, or of softening one of the components so that it sweats to the other. After cooling, the pack is removed from the clamps and rolled to useable thickness. This method and modifications thereof, are used in the jewelry trade today.

Another pressing method is shown in Figure 5. In this system, a multilayered pack is built up, placed on a base, an atmospherically controlled furnace placed over the stack with a hydraulic ram coming down through the roof, heat is applied and while the pack is heating and soaking at a sufficiently elevated temperature, pressure is applied through the ram. After cooling, still under pressure, the stack is separated (there are scaled separating plates between sandwich units) and the bonded assemblies hot and cold rolled to useful sizes.

There are many other pressing and rolling methods described in the literature but these two serve to illustrate the general method.

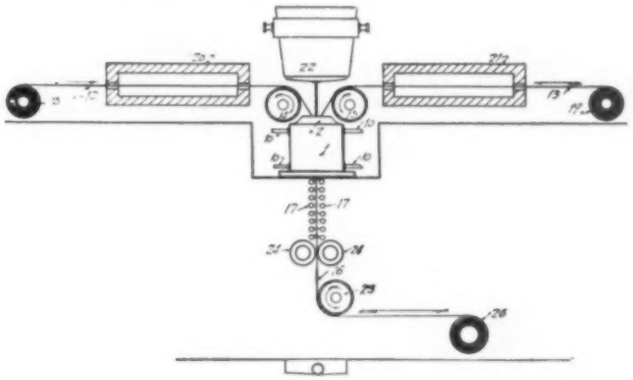
CASTING METHODS

A large part of the tonnage of clad metals made today is produced by the casting method which is generally illustrated in Figure 6.

For the manufacture of stainless, nickel, monel and inconel clad to steel, the methods covered in several patents to Ingersoll are used. Basically, cleaned sheets of the cladding metal are placed face to face with a separating compound between, fusion welded around the edges, placed in a mold and molten metal poured around them. After stripping from the mold, the slab is hot rolled to plate or sheet, the edges trimmed off, and the two single clad plates or sheets separated. These are then further processed to the finished form.

In Figure 7 is a modification of another casting method used in the production of copper clad bars and wire. In the figure, molten steel is shown being poured into the center of a copper tube, resting in a water cooled mold. In the method used by the Copperweld Steel Co., the opposite method is used; i.e., a steel billet

Figure 9 — In this cladding method, molten metal is poured between two preheated strips (patented by E. B. Hudson).



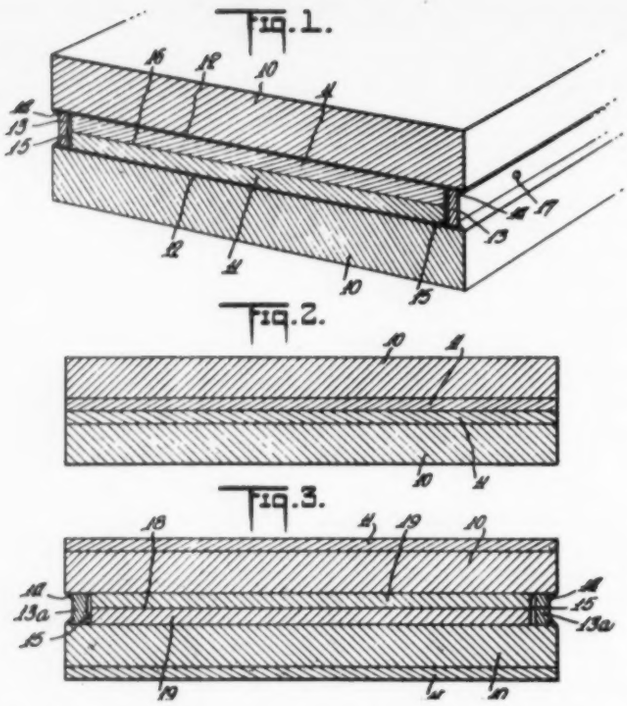


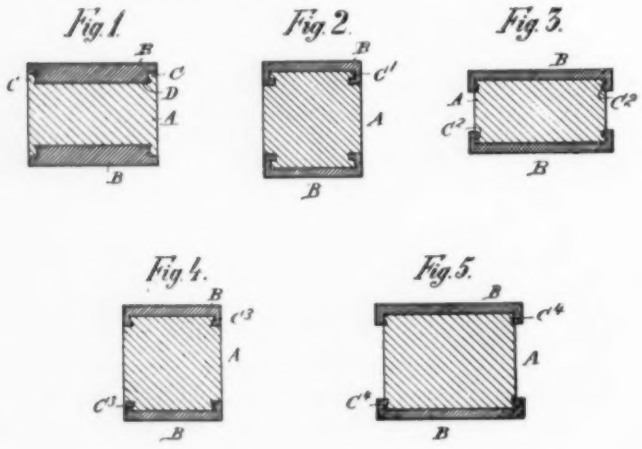
Figure 10 — Sketch illustrates a typical sandwich assembly prepared for hot rolling (patented by W. C. Johnson, et al).

is placed in a mold, heated, and molten copper poured around the steel. In either method, a bond is formed sufficiently strong, so that upon hot rolling, a copper-clad steel bar or wire rod is obtained by ordinary rolling practice.

T. B. Chace has made use of casting (and melting) methods extensively in the manufacture of all types of clad metals. Figure 8 illustrates one of the many ingenious methods developed. An entire paper could be written on the work of this able inventor alone.

An ingenious method of manufacturing clad metals by direct casting is shown in Figure 9. Here molten metal is poured between two preheated strips as they are brought together, the sandwich is then led through a cooling means and rewound. Another Hudson patent leads one solid strip through a molten metal reservoir, said strip being the core of the clad metal.

Figure 11 — Assembly patented by A. Rodig for strip rolling of bi-metallic materials.



Probably the greatest tonnage of clad plate and sheet produced today is made by the sandwich assembly and hot rolling method. There are many methods described in the patent literature and the assembly shown in Figure 10 was selected only because it illustrates clearly the method used by a great many producers.

In building this sandwich, two cleaned plates of the cladding material are placed face to face with a separating compound, usually of aluminum or chromium oxide, between. Some producers weld these plates peripherally, then plate (or spray) the outer faces with iron or nickel. This unit is then placed between two thick slabs or plates of steel, filler bars are located at the edges, and a weld run peripherally, sealing the entire assembly into one solid sandwich. This is heated and hot rolled to desired thickness, the edges sheared off, and the two single clad plates separated and further processed.

Sometimes multiple sandwiches are built up, yielding two single clad and one double clad plates. Sometimes,

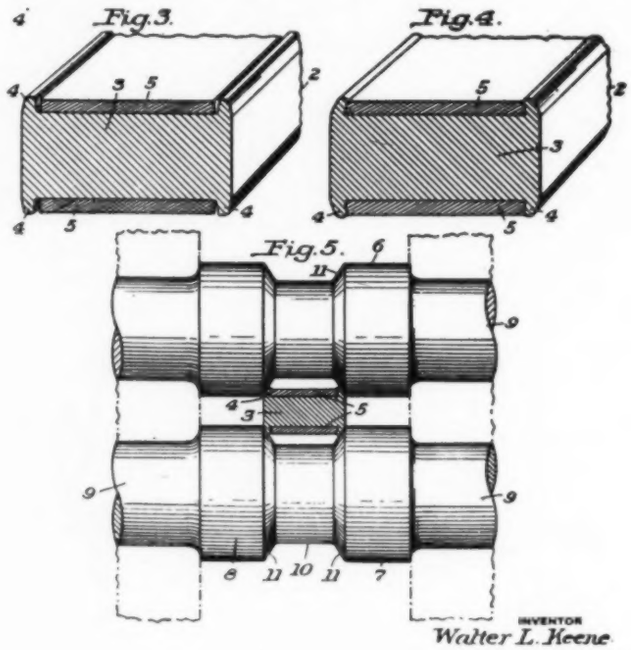


Figure 12 — Essentials of peening method of assembly for strip production, patented by Walter L. Keene is shown in these sketches.

a single clad is re-assembled essentially as described above to make a double clad.

This method has not been widely used for the production of strip because the greater elongation usually imposed in rolling the latter, causes the separating compound to thin out to a point where it becomes ineffective and separation is impossible.

Assemblies for strip rolling were described as far back as 1895. In Figure 11 is shown a few of the ideas for assembly tried in those early days, worked on further by Griffith in 1902 and finally perfected around 1940 at the authors' company.

In Figure 12 is shown the basic essentials of the well known peening method of assembly for the production of strip. In this method, a hot rolled modified channel section is cleaned. A cleaned plate of the cladding metal

is placed between the edgewise flanges and these are rolled over tightly against the edges of the cladding metal component. This assembled billet is then heated and hot rolled by regular strip practice.

In the case of those metals, which do not form bond-preventing oxides, such as copper or nickel, such peening is completely satisfactory. What little air enters at the ends of the billets does no harm. Certain metals must be protected against oxidation during heating in order to obtain a bond early in the hot rolling operation. In such cases a sealing weld is used.

The above peening method has certain limitations as to width because of the thermal expansion factors discussed earlier. In a tightly peened assembly, there is no room for sidewise expansion of the cladding layer. A solution to this problem is shown in Figure 13.

Here is shown a slab of steel to which is welded along each longitudinal edge, a preformed angle. The cladding layer, narrower than the space between the angles, is placed and the angles rolled down. With this feature of adjustable lateral expansion space, there is no practical limit to the width of the assembled slab. This method affords greater flexibility as to width, thickness of cladding layer or layers and even type of metal used either as the cladding or the core. Again, if oxidation at the interface must be prevented, sealing welds may be used. Such assemblies as shown in Figures 12 and 13 are used in the commercial production of copper and nickel clad steel strip and many other combinations.

Not illustrated is a method used prior to the last war in England and Europe for the production of "tombac" clad steel. In this method, sheets of copper-alloy or cupro-nickel were placed on each side of a sheet of steel, the whole wrapped in a steel waster sheet whose edges were then crimped. The pack was heated and hot rolled on a sheet mill to desired thickness, the wrapping pickled off and the clad sheet further cold rolled.

Likewise not illustrated, is a method of manufacturing aluminum clad steel in Germany. In this, roughened strips of steel and aluminum are brought together at a cold mill and sufficient pressure applied as they pass through the rolls, one on top of the other, to effect a useful degree of bonding.

Alclad is generally produced by the rolling method. This usually consists of an aluminum alloy core to which is strapped a corrosion-resisting alloy, selected so as to be anodic to the core, and the assembly hot rolled.

Illustrated in Figure 14 is a method of rolling strips together through a mill. The strips are generally heated under a controlled atmosphere.

There exist modifications of this system in which several furnaces are available for heating the various strips to various temperatures independently of each other.

SINTERING METHOD

A method for producing clad metals that cannot be pressed, cast or hot rolled in the true sense, is shown in Figure 15.

In Figure 15 is shown a powdered metal reservoir at the right, feeding a bearing metal composition, for example, onto the surface of a steel strip. This passes through a furnace, usually having an atmosphere, is sintered, then cooled and in some cases, lightly compacted by rolling. Some systems compact the powder before sintering.

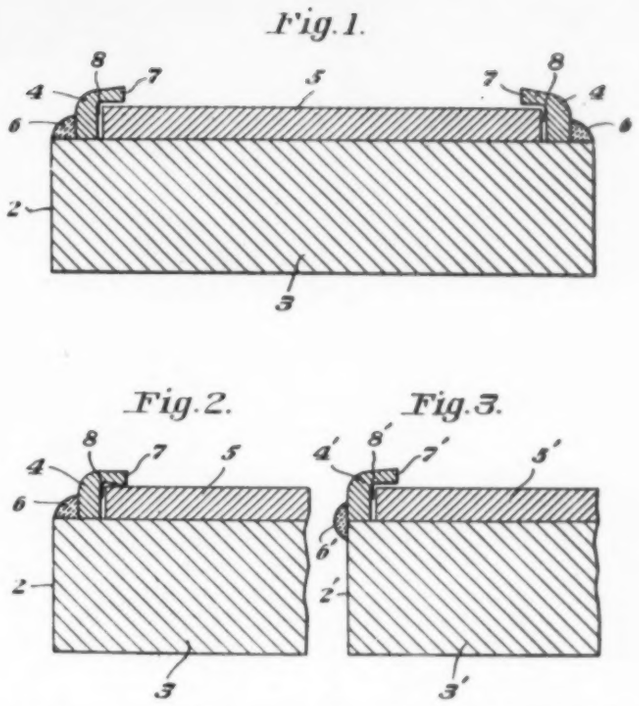


Figure 13 — Sidewise expansion of the cladding layer is permitted in this method patented by Walter A. Keene and W. A. Carlson.

DEPOSITION METHODS

Generally speaking, the deposition of overlapping beads of weld metal onto a steel plate, said weld beads

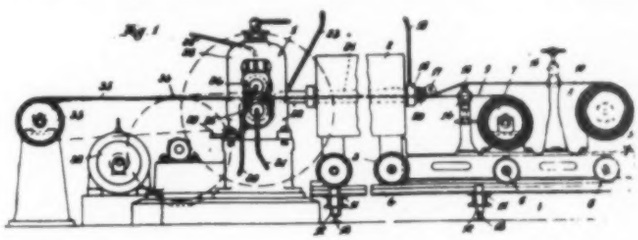
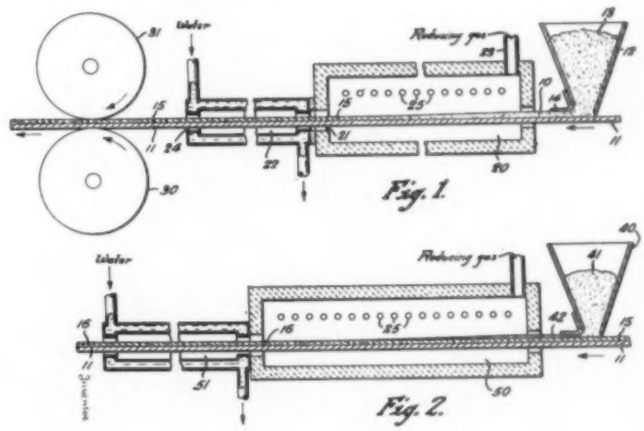


Figure 14 — This method is covered by patents filed by U. Raydt.

Figure 15 — This method of cladding, patented by Rolland P. Koehring, uses powdered metal.



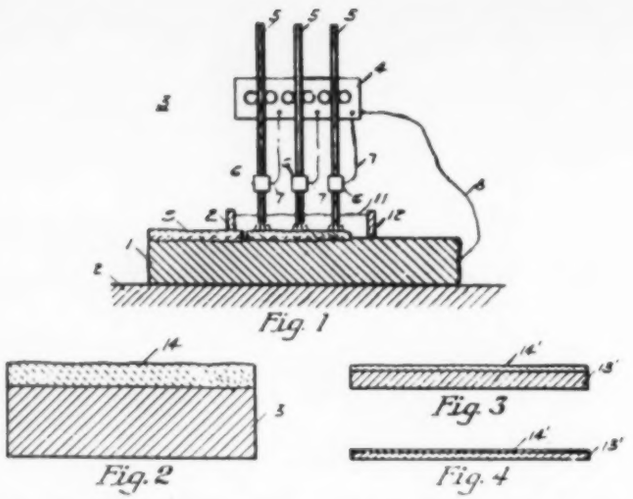


Figure 16 — Electric arcs are used to melt down a granulated mixture placed on the steel slab.

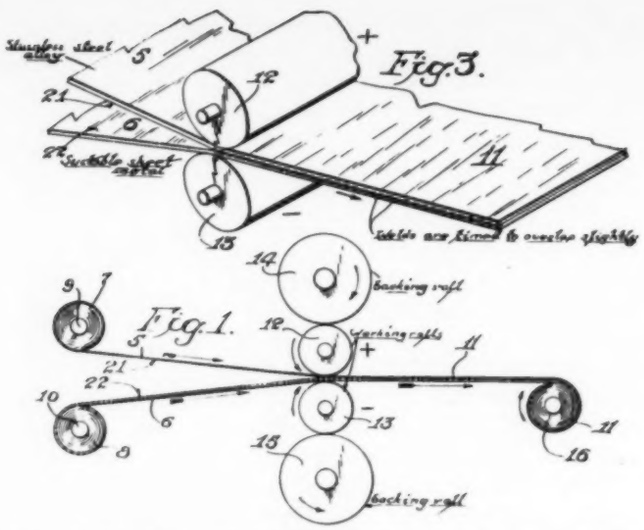


Figure 18 — Welding is used in this cladding method (patented by H. W. Dodson, et al).

being cleaned, ground and rolled might be called a cladding method.

Another method of deposition is shown in Figure 16. Actually, this is called fusion melting. According to the patent, a granulated mixture of ferro-alloys and iron is placed on a steel slab with suitable slagging materials and melted down and fused with electric arcs. After the required surface of the slab is thus covered, the deposit is ground, cleaned and hot rolled.

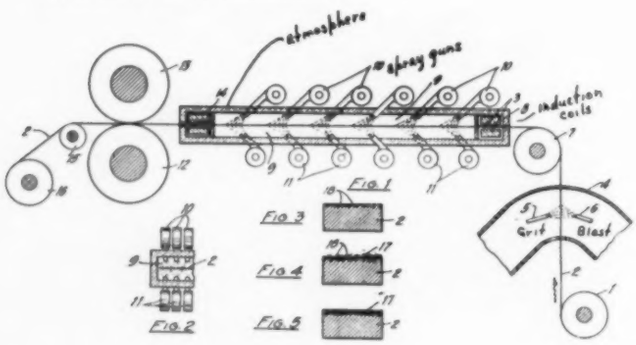
The method shown in Figure 17 might be called deposition, although it actually involves spraying.

Here a steel strip is led through a grit blast, thence through induction coils to raise the temperature, thence through a chamber having a suitable atmosphere, at which time metal is sprayed onto the steel strip by means of well known metal spraying guns. After building up the desired thickness of cladding metal, the material passes through rolls.

UNCLASSIFIABLE METHODS

An important commercial method of producing clad metals does not seem to fit any of the foregoing classifications. It is called "intermelting." As practiced by Allegheny-Ludlum Steel Corp., a mold is built around three sides of a steel slab. Electric arcs, starting at the bottom of the space, travel up the face of the slab, melting as they go, while alloying ingredients are added to the molten pool under a slag. This forms a layer of a steel alloy bonded to the face of the parent slab. For double cladding, this operation is repeated on the other face. After this is completed, the slab is heated and hot rolled by usual practice. The drawback to this system, obviously, is that the cladding must have a steel base; i.e., copper or nickel clad steel cannot be made by the system.

Figure 17 — Spraying is a feature of this cladding method (patented by C. Batcheller).



The method shown in Figure 18 does not fall into the five general categories, either. In this, dissimilar metal sheets are brought together between welds through which a welding current is pulsated. The welds are timed to slightly overlap. Certain metals can be joined in this fashion, but the electrical characteristics of some metals, especially electrical resistance, limit this method to the higher resistance metals.

Other methods of stitch welding have been tried, using ordinary seam welding rolls, with some success.

Whether or not lining vessels by plug welding could be called cladding, is a moot question. Certainly the bond is sketchy, to say the least. However, the method is useful and commercial, consisting as it does of punching many holes in a sheet of corrosion resistance metal, then fastening this sheet to a steel backing by filling the holes with weld metal, which, of course, fastens itself to the edges of the holes.

There may be other ways of cladding, and if no mention has been made of them, the only excuse would be that the field is very broad, men are very ingenious and ten years is not a very long time in which to catch up with all that has been done.

CONCLUSION

In view of the general character of the foregoing discussion, it would be out of place to append hereto, a list of present and potential applications and uses of clad metals. The possibilities are so broad and numerous that any such list would necessarily be incomplete. It should be sufficient to rely upon the imagination of

workers in metals to put clad metals to their proper use.

Appended, hereto, is a list of about 150 workers in the field of clad metals with the numbers of the nearly 300 patents which have been granted to them. This list is undoubtedly incomplete but should serve as a starting point for a complete study of the subject.

APPENDIX

Partial List of U. S. Patents on Composite and Clad Metals

Ligon — 69001 (1867)
Park — 73375 (1868), 192346 (1877)
Absterdam — 97582 (1869)
Meneely — 126894 (1871)
Hastings — 146001 (1873)
Wheeler — 221133 (1879), 234736 (1880)
Fleitman — 242194 (1881)
Haegele — 244230 (1881)
Chinnock — 286904 (1883)
Burdon — 294722 (1884), 381527 (1888), 422713 (1890), 432690 (1890), 440693 (1890), 440694 (1890), 446619 (1891), 460108 (1891)
Pedder — 300730 (1884)
L'Epine — 340223 (1886)
Knight — 346661 (1886), 460750 (1891)
Wall — 374097 (1887)
Palmer — 394603 (1888), 401900 (1889), 456314 (1891), 501157 (1893), 503983 (1893)
Smith — 427924 (1890), 428056 (1890), 432496 (1890), 448594 (1891), 449183 (1891), 532920 (1895)
Merritt — 428727 (1890)
Meyer — 431848 (1890), 440847 (1890), 441884 (1890), 441886 (1890), 443698 (1890), 445814 (1891), 460920 (1891), 460921 (1891), 921722 (1909)
Levez — 470623 (1892)
Martin — 522347 (1894), 625116 (1899), 625117 (1899), 673126 (1901), 673525 (1901)
Rodig — 530719 (1894), 543192 (1895)
Nelson — 542422 (1895)
Michalk — 597012 (1898)
Carlisle — 618165 (1899), 978846 (1910)
Sommer — 625348 (1899)
Bodman — 640866 (1900)
Griffith — 685758 (1901), 704793 (1902), 959517 (1910)
Coleman — 717080 (1902)
Anderson — 729113 (1903)
Low — 776859 (1904)
Schmidt — 785979 (1905)
Williams — 792098 (1905), 792099 (1905)
Slade — 845133 (1907)
Monnot — 894163 (1908), 894164 (1908), 927372 (1909), 947392 (1910), 1001669 (1911), 1063574 (1913)
Krabbe — 907374 (1908)
Astruc — 924413 (1909)
Searle — 925661 (1909)
Berkstrenner — 930927 (1909)
Davis — 935358 (1909)
Grey — 976455 (1910)
Torsell — 987774 (1911)
Canda — 1013860 (1912), 1059525 (1913)
Heintz — 1037143 (1912)
Auth — 1040606 (1912)
Eldred — 1043576 (1912), 1078906 (1913), 1130077 (1915)
Simpson — 1064671 (1913)
Fuller — 1077977 (1913)
Heaton — 1093698 (1914)
Kammerer — 1094423 (1914), 1904241 (1933)
Browne — 1127177 (1915)
De Bats — 1152610 (1915)
Brecht — 1159644 (1915)
Thorp — 1168441 (1916)
Page — 1171637 (1916)
La Potterie — 1180249 (1916)
Sommer — 1189882 (1916)
Heuser — 1196544 (1916)
Rojekof — 1197859 (1916)
Klocke — 1302563 (1919)
Gillespie — 1306690 (1919)
Martin — 1341812 (1920)
Worthington — 1351824 (1920)
Kelly — 1365499 (1921)
Pittevil — 1374110 (1921)
Henderson — 1392416 (1921)
Stresau — 1551590 (1925)
Everett — 1568369 (1926)
Davignon — 1571540 (1926), 1571541 (1926), 1725445 (1929), 2024150 (1935)
Breck — 1580647 (1926)
Jordan — 1679308 (1928), 1985784 (1934)
Andrus — 1680276 (1928), 1840305 (1932), 2015173 (1935), 2219352 (1940)
Dugan — 1680369 (1928)
Johnson — 1690684 (1928), 1824898 (1931)
Killmar — 1703940 (1929)
Landgraf — 1709729 (1929)
Palm — 1729747 (1929)
Fifield — 1864590 (1932)
Armstrong — 1757790 (1930), 1781490 (1930), 1826860 (1931), 1997538 (1935), 2044742 (1936), 2074352 (1937), 2241572 (1941)
McMillen — 1869208 (1932)
Whitehead — 1883205 (1932)
Duff — 1883630 (1932)
Johnson — 1886615 (1932), 2018725 (1935), 2059584 (1936)
Maskrey — 1896411 (1933), 1938633 (1933)
Ingersoll — 1868749 (1932), 1955547 (1934), 1963745 (1934), 1967754 (1934), 1983760 (1934), 2079213 (1937), 2094538 (1937), 2107330 (1938), 2109010 (1938)
Case — 1909252 (1933)
Swearingen — 1920534 (1933)
Meissner — 1927945 (1933)
Austin — 1943853 (1934)
Acre — 1956818 (1934)
Pryde — 1959925 (1934)
Van Osdal — 1963946 (1934)
Walters — 1996183 (1935)
Gibbs — 1996721 (1935)
Frost — 2005338 (1935), 2413317 (1946)
Becket — 2034278 (1936)
Williams — 2036667 (1936)
Harvard — 2056673 (1936)
Sommer — 2057254 (1936)
Ostendorf — 2064684 (1936), 2199321 (1940)
Meier — 2091871 (1937)
Stargardter — 2093874 (1937)
Weder — 2094482 (1937), 2094483 (1937)
Schwarzkopf — 2096924 (1937)
Hopkins — 2107943 (1938), 2151914 (1939), 2191469 (1940), 2191470 (1940), 2191471, —472, —474, —475, —476, —477, —478, —479, —480, —481, —482 (all 1940), 2226403 (1940)
Cykajlo — 2108528 (1938)
Bate — 2113074 (1938)
Hudson — 2128941 (1938), 2128942 (1938), 2128943 (1938)
Gordon — 2133291 (1938), —292, —293, —294 (1940)
Raydt — 2138982 (1938), 2267665 (1941)
Huston — 2147407 (1939), 2225868 (1940)
Chace — 2125153 (1938), 2145248 (1939), 2156331 (1939), 2169354 (1939), 2173433 (1939), 2174733 (1939), 2190310 (1940), 2193246 (1940), 2195613 (1940), 2195614 (1940), 2199150 (1940), 2211912 (1940), 2220210 (1940), 2226695 (1940), 2235199 (1941), 2235200 (1941), 2249417 (1941), 2268565 (1942), 2268566 (1942), 2270267 (1942), 2270830 (1942), 2275585 (1942), 2291026 (1942), 2366178 (1945), 2325659 (1943)
Koehring — 2158461 (1939), 2198253 (1940)
Orr — 2159043 (1939), 2160558 (1939), 2160559 (1939)
Moses — 2164074 (1939)
Kinkead — 2175606 (1939), 2175607 (1939)
Hodson — 2187348 (1940)
Gibbons — 2193231 (1940)
Tranier — 2214002 (1940)
White — 2219434 (1940)
Marvin — 2241094 (1941)
Queneau — 2241789 (1941)
Zieus — 2247829 (1941)
Medsker — 2253526 (1941), 2255076 (1941)
Kramer — 2258327 (1941)
Reeve — 2261412 (1941)
Hobbs — 2266320 (1941)
Holmquist — 2266972 (1941)
Schwartz — 2267342 (1941)
Deutsch — 2269523 (1942)
Brown — 2275503 (1942)
McCullough — 2283217 (1942), 2283218 (1942), 2283219 (1942)
Dodson — 2288184 (1942)
Hensel — 2294404 (1942), 2433903 (1948)
Young — 2309288 (1943)
Patrick — 2312582 (1943)
Ronay — 2361962 (1944)
Carlson — 2386091 (1945)
Keene — 2388694 (1945), 2395877 (1946), 2395878 (1946), 2417760 (1947), 2421891 (1947), 2468206 (1949), 2473686 (1949), 2514873 (1950)
Mudge — 2390452 (1945)
Nachtman — 2402834 (1946)
Mann — 2405220 (1946), 2405221 (1946), 2405222 (1946)

Egan — 2409422 (1946)
Doyle — 2414510 (1947)
Dyar — 2414511 (1947)
Batcheller — 2414923 (1947)
Mehl — 2416400 (1947)
Goulding — 2423810 (1947), 2423811 (1947)
Potter — 2450987 (1948)
Marshall — 2510123 (1950)

DISCUSSION

PRESENTED BY

J. H. CROWE, Division Superintendent, Republic Steel Corp., Canton, Ohio.

R. G. FLEMING, Superintendent Permaclad Div., Alan Wood Steel Co., Conshohocken, Pa.

WALTER L. KEENE, Director of Research, Superior Steel Corp., Carnegie, Pa.

J. H. Crowe: We would first like to remark that industry has needed this paper for some time, and that in no small measure it will help to properly classify the greatly increasing number of surface finishes in the flat roll industry.

This brings to mind the relatively small number of flat roll types and finishes available 30 years ago, as compared to the present time. You, who are old enough, can recall that the sheet mill products available in the early twenties, consisted of: black, pickled, galvanized and terne plate sheets, and at the tin mills: black plate, tin plate and terne plate. Today, with the aid of the continuous hot and cold mills, electroplating lines, new methods for porcelain enameling and the tremendous development in the stainless and alloy fields, the number of surface finishes for special uses, obtainable in flat roll, seem almost endless. The point I wish to make is that Mr. Keene's work in collecting and cataloging an important branch of this development is certainly a major step in the right direction.

We can all appreciate the difficulty Mr. Keene has been confronted with in writing a definition for "clad metals" due to the great number of flat rolled products which might tend to overlap. However, I feel that he is on very solid ground and cannot be prodded too much. There is one point that possibly needs some further discussion. That is, why was a 3 per cent minimum chosen as the smallest component? I am thinking of the hot dipped galvanized sheet on which approximately 6 per cent zinc is solution bonded to the steel surface, which might overlap into this definition.

There are a number of disclosures in this paper which should help those interested in clad. I refer first to Mr. Keene's description of the control of carbon migration by the use of nickel or cupro nickel. His work on hot hardness and thermal expansion charts will definitely help in obtaining more satisfactory bonds. Finally, note the emphasis placed on rolling as a major part of the cladding process. This operation gives extremely high line contact pressures which in conjunction with the proper temperature, results in a more positive bond. We have been producing a stainless clad product for some years and have found out, sometimes the hard way, that these facts are all of fundamental importance in obtaining a satisfactory cladded product. This paper will give the flat roll industry a clearer conception of the product known as "Clad Metal."

R. G. Fleming: At Alan Wood Steel Co. we use the sandwich method of assembly in producing our stainless clad sheets and it is that method that I wish to discuss.

Originally we used 0.010 in. of nickel plating to secure a sound bond and to prevent excessive carbon migration. Through extensive experimentation we have been able to reduce this plating thickness to 0.001 in. and still produce a satisfactory clad sheet. I would like to ask Mr. Keene what he has found to be the optimum thickness of plating necessary to ensure a sound bond and minimize carbon migration.

Another very important factor in the production of clad steels is the separating compounds. We use aluminum oxide with a lacquer vehicle with satisfactory results. Mr. Keene mentioned chromium as a parting agent. Our experience with chrome oxide has not been successful due primarily to our inability to develop an adequate vehicle. We are very much interested in the use of chrome oxide as a parting agent and are currently attempting to develop a satisfactory vehicle.

I would appreciate Mr. Keene's opinion of the relative merits of aluminum and chrome oxide as parting agents.

W. L. Keene: While there has been activity in clad metals for nearly a century, it is only recently that they have reached the status of useful, commercial metals, especially in the form of plate, sheet and strip. Emerging from relative obscurity into an already crowded field of coated, plated, covered, combined and composite materials, the expected happened. Confusion reigned! The question as to "what is a clad metal?" had to be answered every day. Some even wanted to know what good they were!

Because of this situation, I welcomed the opportunity of reviewing the entire "combined metal" field and then attempted to clarify the picture by definition. Admittedly the definition that I have given is not perfect — it is merely an attempt to draw a couple of boundary lines.

Mr. Crowe quite properly raises the question as to why I chose the 3 per cent boundary as the mass of the smallest component. My authority for that figure appears in the Metals Handbook, 1948 Edition, in an article entitled, "Composite Steels" by T. S. Fitch. I questioned Mr. Fitch as to why he chose the 3 per cent figure in his definition of "composite steels" and he said that he had to draw a line somewhere and 3 per cent was a logical place to draw it. I quite agree. I have, however, tried to draw several more lines around clad metals to differentiate them from the larger field of composites. In trying to keep electroplated metals away from clad metals, however, it seems that I have not completely eliminated hot-dipped galvanized, unless one interprets my term, "in a rolled product" as meaning rolling is the final step in the processing sequence. If we should raise the 3 per cent minimum to 5 per cent, we might minimize some of the overlapping. I believe most clad metal producers will agree that 5 per cent is about the lowest practical limit for a clad metal.

In answer to Mr. Fleming's question as to the optimum thickness of plating necessary to insure a sound bond and minimize carbon migration, it is rather difficult to set limits unless consideration is given to all factors such as original thickness of the components of

the assembled slab; the reduction imposed in rolling to finished thickness; the end-use; and most important, the type of clad metal being made. I may not have made it clear that the problem of carbon migration is much more serious in straight-chrome stainless clad to carbon steel than in chrome-nickel stainless clad to carbon steel. In the former, damaging migration takes place during the long-time box annealing cycle usually imposed during the processing of this type of material, (especially if the end-use involves deep-drawing) unless there is a "carbon-stopping" agent interposed between the layers during assembly of the slab prior to hot rolling. Austenitic chrome-nickel stainless clads are never box-annealed, (at least for long periods followed by a slow cool) as such treatment would render this type of stainless completely unfit for service.

In the case of the straight-chrome stainless clads, we have found that iron, plated on or inserted in the form of sheet, is not as effective as copper in some form or alloy, as a carbon-stopper. Iron or nickel, plated onto the stainless face which is then placed in contact with the slab of steel to which it is to bond, have been found advantageous in securing an early bond during hot rolling and these materials are used in the manufacture of chrome-nickel stainless clad steels. They would likewise be of assistance in obtaining an early bond in the case of the straight-chrome stainless steels, but are not as effective as copper or a copper-alloy in preventing carbon migration at elevated temperatures. Cupronickel is preferred over pure copper as a buffer layer because of its high softening point which permits hot rolling at more desirable temperatures.

We have not found it necessary to use cupro-nickel as a carbon-stopper in the case of the chrome-nickel stainless clads — only in the straight-chrome types. An initial thickness sufficient to result in a final thickness of approximately 0.0005 in. at the bond line appears to be sufficient to stop the carbon from crossing from the steel to the straight-chrome stainless. This means an initial thickness of 0.020 in. in a 3-in. billet, which is hot rolled to about 0.080 in. before box annealing. Undoubtedly such a thickness is unnecessary to secure a bond. The two types of stainless react so differently that we should not even discuss them at the same time. The 0.001 in. of nickel used by Mr. Fleming to secure bonding would undoubtedly do a good job, *if* the stainless involved were the chrome-nickel type, but I doubt if such a thickness would be effective in stopping carbon migration in the case of the straight-chrome type stainless bonded to carbon steel. Here again, however, we have to define our terms. All of my remarks are directed at the production of light gage strip or sheet for deep drawing purposes. Prevention of migration is not so important if we are considering heavy plate or sheet that is not subjected to severe cold forming.

Referring to the question on separating compounds, I do not feel qualified to comment on the relative merits of aluminum oxide vs chromium oxide. I have the impression that both have been used successfully, but inasmuch as our cladding methods do not involve the use of a parting compound, I cannot speak from experience. All of our clad metals are made with the cladding metal on the surface, whereas other systems start with the cladding metal on the inside of the assembled slab, said cladding metal later being exposed by shearing and separating after hot rolling. However, even on our "outside-outside" system of cladding, we know that the film of chrome oxide naturally present on any type of stainless steel will quite effectively hinder bonding. It is necessary to stretch and rupture this film by rolling reduction in order to obtain a bond. As this film is mainly chrome oxide, I would consider this material rather effective and useful, as an alternate to aluminum oxide.

BOTTOM CASTING OF INGOTS FOR THE MANUFACTURE OF PLATES*

▲ Bottom casting is an old established practice for producing ingots for the manufacture of steel plates both in this country and in Europe. Most of the steel plate producers in the eastern section of the United States employ this method of casting. A survey of the industry, however, shows that most of the ingots cast are top poured — that is poured direct from the ladle to the molds — and this is quite understandable when the economics of the two practices are considered.

It is readily apparent that bottom casting is more expensive than top casting because (1) there is an extra cost in the additional refractories required, (2) a larger casting pit crew is necessary, (3) there is a loss in yield due to runner scrap and (4) a larger and more varied mold inventory is generally necessary. Despite these disadvantages that create a higher ingot cost, bottom casting is still being used, and will continue to be used because there are other desirable features obtained from the practice that affect the entire process for producing steel plates and quality of end product.

The main advantages of bottom casting ingots for the manufacture of plates are:

1. Good surface quality ingots that can be rolled direct to plate with one mill heating operation.
2. A slabbing mill is not required.
3. Better yield from ingot to plate.
4. It is the most efficient method for casting small ingots.

In addition, bottom pouring practice serves a very useful purpose in the steel industry, particularly to the small producers, in producing good quality ingots for the manufacture of steel plates. Furthermore, it is the best practice for making small ingots. The quality of the steel produced is equally as good as that obtained in top pouring practice and the higher plate yield is attractive.

There are hazards in the practice that must be avoided such as break-outs, defective refractories and attention to detail in preparing and assembling the bottom plate, but with the necessary controls the rewards are ample to justify its use in the manufacture of steel plates.

*Abstracted from paper by T. T. Watson, Director of Research, Lukens Steel Co., Coatesville, Pa., presented at AISI 1951 Philadelphia Regional meeting.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, April 28, 1952 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Men, Molds and Machines," by D. V. Ericson, Manager Sales Research, Stockham Valves & Fittings Co.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, April 8, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

INSPECTION TRIP

Ontario Paper Co., Thorold, Ontario, Canada.

"Development of Labrador Iron Ore," by W. H. Durrell, General Manager, Hollinger Hanna, Ltd., Montreal, Quebec, Canada.

Hotel Henley, St. Catherines, Ontario, Canada.

▲

CHICAGO SECTION

Wednesday, April 9, 1952 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Mercury Arc Rectifiers on Main Roll Drives," by H. W. Poole, Manager, Steel Mill Div., Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

Phil Smidt's Restaurant, 1205 N. Calumet Ave., Hammond, Ind.

▲

CLEVELAND SECTION

Monday, April 21, 1952 at Cleveland, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

Tuesday, April 22, 1952 at Youngstown, Ohio — Dinner 6:30 P.M., Meeting 8:00 P.M.

MONTHLY MEETING

Cleveland, Allerton Hotel, Cleveland, Ohio

Youngstown, El Rio Club, Youngstown-Warren Rd., Route 422, Youngstown, Ohio

▲

DETROIT SECTION

Tuesday, April 8, 1952 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Semisilica Refractories Lessen Furnace Structural Failures," by G. Bickley Remmey, Richard C. Remmey Son Co., Philadelphia, Pa.

Horace Rackham Educational Memorial, Detroit, Mich.

▲

PHILADELPHIA SECTION

Saturday, April 5, 1952 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Submerged Arc Welding," by O. M. Fromm, General Foreman of Electric Welding, Electrical Department, Bethlehem Steel Co., Sparrows Point, Md.

"Paints for Maintenance," by S. C. Frye, Research Department, Bethlehem Steel Co., Bethlehem, Pa.

"Realigning of Open Hearth Crane Runway and Building Structure," by M. F. Reese, Foreman, Steel Erectors, Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.

"New Developments in Lubrication Practice," by C. M. Schaeffer, Lubricating Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

▲

PITTSBURGH SECTION

Monday, April 14, 1952 — Dinner 7:00 P.M., Meeting 8:00 P.M.

INSPECTION TRIP THROUGH PLANT OF
Continental Can Co., Inc., Lebanon Road, Pittsburgh, Pa. (Meet inside main gate at 4:00 P.M.)

"Tin Plate Requirements, Present and Future," Paper presented by Research Staff of Continental Can Co., Inc. Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

SPECIFICATIONS FOR DESIGN OF HOT METAL LADLES

AISE STANDARD NO. 9

(TENTATIVE)

SEPTEMBER 30, 1951

PUBLISHED BY
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

Copyright 1952 by Association of Iron and Steel Engineers and printed in USA.

AISE STANDARD NO. 9

SPECIFICATIONS FOR DESIGN OF HOT METAL LADLES

(TENTATIVE)

(SEPTEMBER 30, 1951)

1. GENERAL

A. This specification shall be known as Specifications for Design of Hot Metal Ladles, AISE Standard No. 9, and shall cover such open top hot metal ladles of circular or oval cross-section as are used in steel mills for transporting molten metal. Insofar as applicable these specifications may be used in the design of other types of hot metal ladles.

B. These specifications are intended to cover only materials (by reference) and the more important structural design features, such as thickness of sidewalls and bottom, proportions of stiffener rings, etc. Supplementary specifications covering special features may be added by purchaser.

2. WORKMANSHIP, AND INSPECTION

A. Workmanship and material shall be first class in every respect, and subject to the inspection of purchaser's representative at all times.

3. MATERIALS

A. Materials for the following parts of the ladle shall be in accordance with the latest revision of the following specifications:

(a). *Bottom plate* — ASTM, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates of Flange and Firebox qualities, A-285, firebox quality, grade C.

(b). *Shell plate, stiffener rings, splash plates, trunnion block* — ASTM, Specification for Steel for Bridges and Buildings, A-7. If the A-7 steel used exceeds 1-in. and does not exceed 2½-in. thickness, the steel must also meet the requirements of AWS Specification No.D2-0-47 Standard Specification for Welded Highway and Railway Bridges.

If specified on the information sheet, material shall meet the requirements of A-285, grade C firebox quality for thicknesses up to and including 2 in. For thicknesses over 2 in., if specified on the information sheet, the material must meet requirements of specification ASTM A-201, Grade A, flange quality.

(c). *Trunnion pin, miscellaneous forged fittings* — ASTM, Specification for Carbon Steel Forgings for General Industrial Use, A-235, Class C, normalized or annealed (unless integral part of cast steel trunnion band or pad).

(d). *Trunnions* — ASTM, Specification for Mild to Medium Strength Carbon Steel Castings for General Application, A-27, Grade 60-30 or ASTM A-216, WCA.

(e). *Rivets* — ASTM A-31, boiler rivet steel, Grade A.

(f). *Lining* — As specified on information sheet.

4. DETAILS OF CONSTRUCTION

A. Details of construction not provided for in this specification shall be consistent with good practice in ladle design.

B. The bottom plate may be "flat" or "dished" and shall be flanged around the edge by hot forming with an inside radius not less than 3 and preferably 4 or more times the thickness. Connection to the sidewall shall be either by a full penetration double butt weld or by a lap riveted joint.

C. Openings in the ladle bottom for nozzles shall be fully reinforced by a welded stiffener plate. Recom-

mended practice for these and other similar details shall conform with good practice as recommended by the 1950 ASME Code for Unfired Pressure Vessels, or later edition thereof. Details of welded ladles, or sub-assemblies, and welding symbols shown on drawings, and welding procedure shall conform with latest recommended practice of the American Welding Society.

D. The trunnion pin where it fits in the trunnion plate should not be reduced in diameter for this fit, but may be increased, in which case the fillet should be made to as large a radius as is possible.

E. Trunnion pins, which are press or shrink fitted into the block, shall preferably be installed after the ladle has been stress relieved.

F. If specified by the purchaser, trunnions for open hearth steel teeming ladles shall be provided with steel bushings to take the wear. Also, if specified by the purchaser, the trunnions for ladles which are tilted for pouring shall have oil-less type bronze bushings (for 700 F temperature) fixed to the trunnion pin, and cast steel sleeve with collar revolving on the bushing.

G. Safety flanges shall preferably be provided on the end of the trunnion pin to guide the ladle hook into proper engagement.

H. Open hearth ladles shall be provided with a splash plate underneath the slag spouts, to prevent splashing slag from sticking to side plates of the ladle and building up on the stiffening ribs or bands. The plate shall be bolted and arranged to permit removal for inspection of ladle. This plate shall be a close fit around the spout and extend down below the lower rib. Allowance shall be made for expansion of the plate.

I. If so specified by the purchaser, teeming ladles shall be provided with heat protection plates around the pouring nozzle.

J. The ladle is to be stress relieved by uniformly heating in a furnace. The temperature of the furnace, when the ladle is put into it, shall not be over 300 F at start and increased to 1200 F at a rate not exceeding 200 F per hour, then held at that temperature for one hour per inch of thickness of ribs. It shall then be cooled in the furnace at a rate (not exceeding 200 F per hr) to 500 F, before being taken from the furnace.

K. Vent or weep holes will be provided in the bottom of the ladles. Examples of good practice in this regard are ½-in. holes on 9-in. centers or ⅜-in. holes on 8-in. centers. Weep holes may be provided on side of ladle, if specified on information sheet.

5. DESIGN STRESSES AND DESIGN ASSUMPTIONS

A. The combined center of gravity of the ladle and the molten metal when full shall be safely below the centerline of the trunnions, and trunnions shall be located at least 65 per cent of the overall vertical height above the lowest point of the shell. If trunnions must be located lower due to crane clearance, trunnions should be provided with lock bars or other means to prevent accidental tilting of the ladle.

B. Formula given in this specification are based on molten metal which has a unit weight of 430 lb per cu ft.

C. The following stresses will not be exceeded in the design of the ladle. These stresses are based on the use of the materials outlined in Section 3 A.

a. In members where the axial stress through the thickness is nearly constant, the stress shall not exceed 8000 psi. (Example: Direct stress in ladle wall or dished bottom).

b. Stresses in members which are subject to bending or combined bending and direct load shall not exceed 16,000 psi. (Example: Stress in stiffener ribs). An exception is the trunnion pin. See Section 5E.

c. Stresses in members which do not help appreciably in carrying load, but which are secondary stresses or due to stress concentrations at discontinuities shall not exceed 24,000 psi. (Example: Normal stress due to bending at juncture of sidewall and bottom of dished bottom ladles).

D. The maximum allowable shear stress shall be 0.6 times the allowable tensile or compression stress.

E. The maximum normal stress in the trunnion pins due to bending, neglecting stress concentrations in fillets, shall not exceed 8000 psi. The *average* shear stress in the trunnion pins shall not exceed 2400 psi, computed by dividing the total shear by the area of the pin. (Maximum shear stress will be about double average shear stress in a circular section). In calculating the bending moment in the trunnion pins, the lifting force shall be assumed to act 1 in. in from edge of collar of trunnion pin.

F. The average bearing stress between the trunnion pin and trunnion block in the ladle shell shall be calculated by the following formula:

$$f_B = \frac{W}{2D_B t_T}\left(1 + \frac{6e_2}{t_T}\right)$$

(See Figure 1 for notation)

but in no case shall this stress exceed 20,000 psi.

G. The trunnion blocks shall be rigidly connected to the ladle shell through ribs or other stiffening devices. Unit stresses in such connecting devices shall not exceed 16,000 psi.

6. DESIGN OF BOTTOM PLATES OF FLAT BOTTOM LADLES

A. Notation used in this section is shown in Figure 2. Slightly dished ladle bottoms shall be considered as "flat" if the dishing radius "R" (See Figure 3) is more than 10 times the minimum radius "r" of the bottom plate.

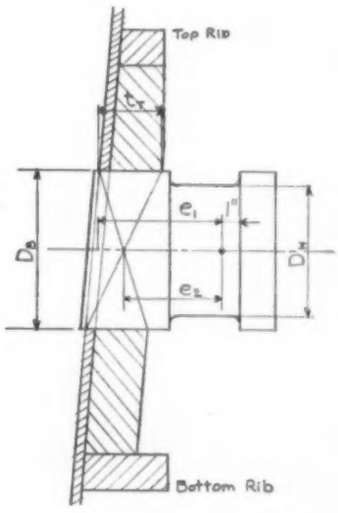


Figure 1—Sketch shows notation used at trunnion pin.

B. Circular flat bottoms with no reinforcing plate shall have a thickness not less than

$$T = \frac{D\sqrt{H}}{625}$$

C. Reinforcing plates, if used, shall be placed on the inside of the ladle bottom, and shall be riveted to the bottom plate in a row or rows around the circumference, as well as throughout the entire reinforcing plate area, so as to make the two plates act as a unit. The diameter "d" of the reinforcing plate shall not be less than 0.88 times the diameter "D" of the bottom plate.

D. When a reinforcing plate is used, the combined thicknesses of the reinforcing plate (T_R) and bottom plate (T_B) shall not be less than:

$$T_B + T_R = \frac{D\sqrt{H}}{510}$$

The thickness of the bottom plate (as distinguished from the reinforcing plate) shall be at least $\frac{1}{16}$ in. more than one-half the combined thickness of the two plates.

E. When the molten metal to be handled has a unit weight "q" appreciably different from 430 lb per cu ft, the required minimum thicknesses shall be those given by the foregoing formulas, multiplied by $\sqrt{\frac{q}{430}}$

F. In the case of "oval" ladles, having a maximum bottom plate diameter not more than 1.4 times the minimum bottom plate diameter (see Figure 2), the foregoing formulas for bottom plate thickness as given in this section may be used by replacing circular bottom plate diameter "D" by an equivalent diameter for the oval ladle, "D_E", determined by the following formula:

$$D_E = \frac{D_{max} + D_{min}}{2}$$

7. DESIGN OF BOTTOM PLATES OF DISHED BOTTOM LADLES

A. The notation used in this section is shown in Figure 3. A ladle bottom may be considered as "dished" providing the dishing radius "R" is less than 10 times the minimum radius "r" of the bottom plate. The dishing must be to the shape of a spherical segment in circular ladles and in the end sections of oval ladles. The center section only of an oval ladle may be dished to a cylindrical shape.

B. The bottom plate thickness for dished circular bottoms shall be determined by the following formula:

$$T = \frac{\left[15.2 + 0.60H\left(0.1 + \frac{r}{R}\right)\right]R}{10{,}000}$$

Figure 2 — Notation used in specification for flat bottom ladles is given in this sketch.

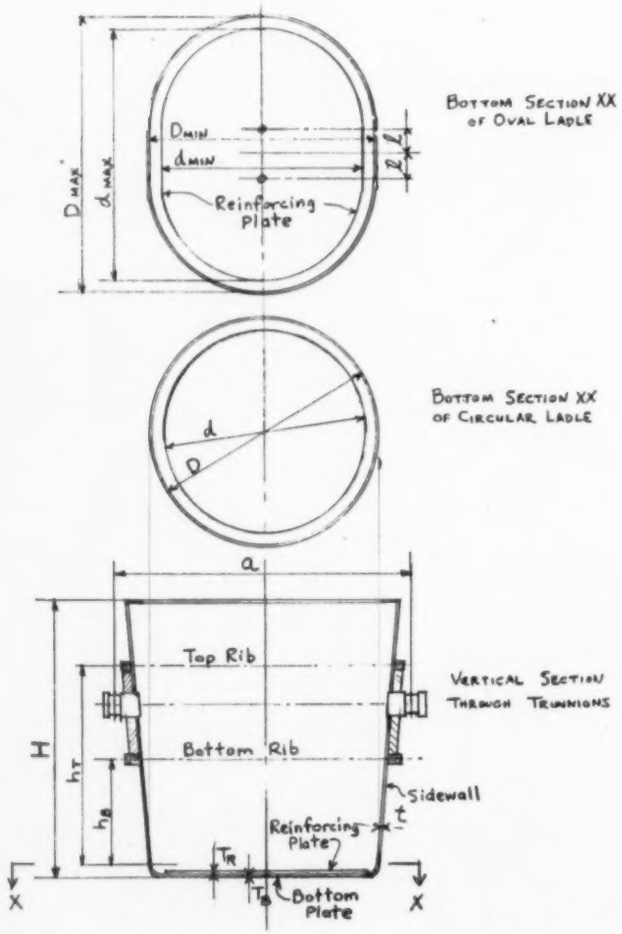
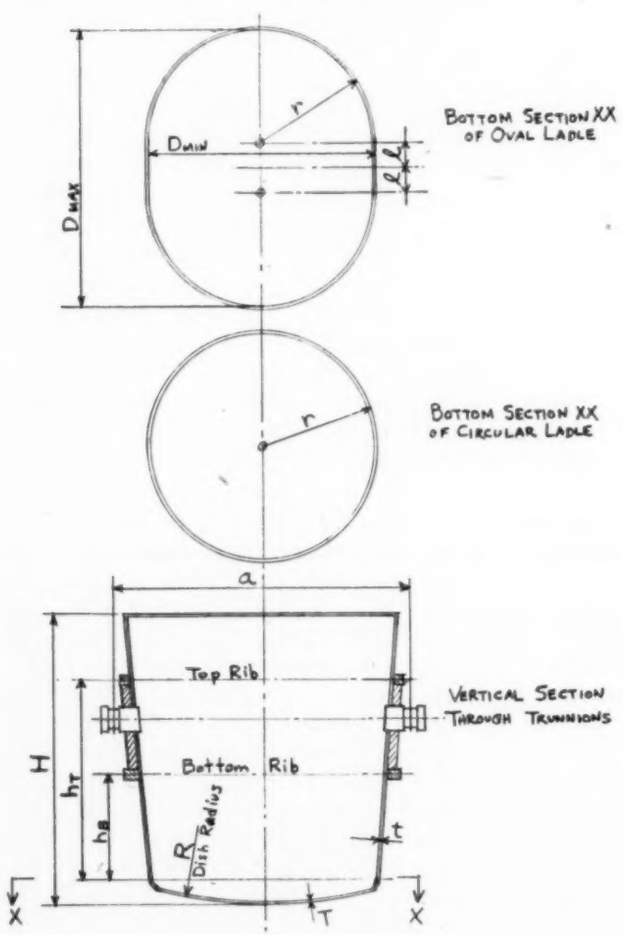


Figure 3 — Notation used in specification for dished bottom ladles is given in this sketch.



C. Oval dished ladle bottoms (Figure 3) having a maximum diameter not more than 1.4 times the minimum diameter shall have a bottom plate thickness determined by the following formula:

$$T = \frac{\left[15.2 + (0.64\frac{D_{max}}{D_{min}} - 0.04)H(0.1 + \frac{r}{R})\right]R}{10{,}000}$$

D. If the molten metal to be transported has a unit weight "q" per cu ft that is appreciably different from 430 lb per cu ft, the thickness is to be determined by the formulas in this section modified by multiplying the term "H" in the numerator by $\frac{q}{430}$.

E. Reinforcing plates, if used, are not to be considered as effectively adding to the strength of dished bottoms.

8. DESIGN OF STIFFENER RIBS

A. The tendency of the ladle to collapse when suspended by the ladle hooks may be resisted by two stiffener ribs or rings, one above and one below the trunnion pad or framing, designated by the subscripts T and B, for top and bottom, respectively. The lip reinforcement of the ladle is not to be considered in calculating the stresses in the ladle ribs. The strength of each rib is to be determined on the basis of allowable stress, as calculated by the following procedure, which stress is not to exceed 16,000 psi.

B. Each "effective rib" shall consist of the stiffener ring together with a portion of the adjacent ladle sidewall of "effective width = b_e," provided however that the rib or band be welded or riveted to the ladle sides. Welding is recommended and should be continuous. If the ribs and trunnion band are not riveted or welded to the sides, no part of the sidewall shall be included in calculating the properties of the "effective rib."

C. If the sidewall thickness is the same both above and below a rib, the total width of the ladle shell to be used in calculating the section properties of the effective rib shall be taken as:

$$b_e = b_r + 1.4\sqrt{R_S t}$$

where b_r = width of rib stiffener
R_S = sidewall radius
t = sidewall thickness at stiffener

If the sidewall thickness changes at a rib, the total width of the effective rib shall be taken as:

$$b_e = b_r + b_1 + b_2$$

where b_1 is the effective width of the thicker portion (thickness t_1) of the sidewall and b_2 the thinner portion (thickness t_2) as follows:

$$b_1 = 0.4\sqrt{R_S(t_1 + 2t_2)}$$

$$b_2 = 0.7\sqrt{R_S t_2}$$

D. After determining the effective width by Section 8C, the area, moment of inertia, section modulus, and effective radius of each rib are to be calculated. By effective radius is meant the radius of the neutral axis of the effective rib at the centerline of the stiffener.

These properties and other necessary information will be designated as follows:

A_T = effective area of top rib
A_B = effective area of bottom rib
h_T = vertical height of top rib stiffener centerline above juncture of ladle bottom and sidewall
h_B = vertical height of bottom rib stiffener centerline above juncture of ladle bottom and sidewall
R_T = effective radius of top rib
R_B = effective radius of bottom rib
I_T = moment of inertia of effective top rib
I_B = Moment of inertia of effective bottom rib
S_{TO}, S_{TI}, S_{BO}, S_{BI} = section modulus for outer or inner surface of top or bottom effective rib, as designated by subscript O or I, T or B, respectively
W = total weight of ladle, lining, and molten metal when filled to maximum height
a = distance between lifting hook centerlines
c = distances from vertical section through trunnion pin to sections of top rib which are being checked for strength in region of trunnion. See Figure 4. This a variable distance.
l = in an oval ladle, one-half the width of the straight side
R_M = mid-height radius to middle plane of sidewall

E. The effective ribs develop compressive forces, with resultant parallel to the trunnion pin axis, that may be computed by the following formulas:

$$C = \frac{I_B h_B R_T^3}{I_T h_T R_B^3} = \text{a constant}$$

Figure 4 — Method of making rib moment calculations as required by Section 8 F and 8 G is illustrated by this sketch.

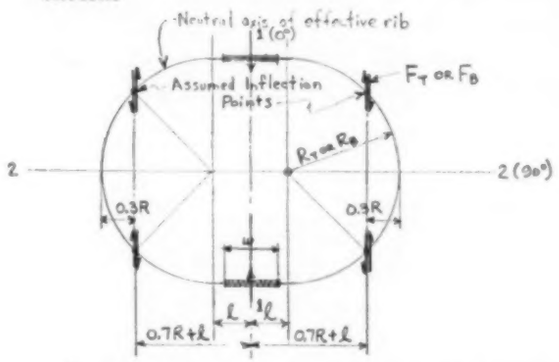
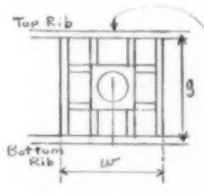
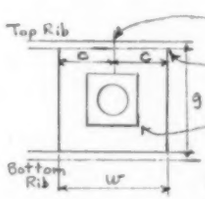


FIG 4A - ASSUMPTIONS FOR CALCULATING RIB MOMENTS (REFER TO SECTION 8F and 8G)



Calculate Stress at this section assuming $c = \frac{w}{4}$, but with maximum c not more than $\frac{g}{3}$. (Section G1)

FIG 4B OPEN BOX TRUNNION FRAMING



Calculate stress here on basis of $c = \frac{w}{4}$ with maximum c not more than $\frac{g}{3}$.

Calculate stress here on basis of $c = \frac{w}{2}$ on unthickened sidewall

Stress may be checked at other possible critical values for c as indicated using thinner section.

FIG 4C PAD TRUNNION SUPPORT

$$F_T = \frac{W(a - 1.27R_M)}{8\ (Ch_B + h_T)} = \text{force in top rib}$$

$$F_B = CF_T = \text{force in bottom rib}$$

F. The rib bending moments are calculated by assuming that the inflection point of zero moment in each effective rib is located at a distance $0.3R_T$ or $0.3R_B$, measured inward from the rib neutral axis parallel with the cross axis of the ladle. See Figure 4A. By cross axis is meant the axis at right angles with the trunnion pin axis. Use plus and minus signs exactly as given in the following formulae which are based on the force diagram shown in Figure 4A. Plus rib bending moments indicate compression on the outside of the rib and tension on the inside of the rib. Minus rib bending moments indicate tension on the outside and compression on the inside of the rib. Minus signs for stresses indicate compression and plus signs for stresses indicate tension in accord with the usual practice.

G. Rib bending moments are to be calculated as follows:

(1). Top rib above trunnion, at weakest section, that is, at trunnion axis in the case of open box framing (Figure 4B) or at edge of pad (Figure 4C) if trunnion housing is carried to upper rib and welded thereto. This moment may be calculated as follows:

$$M_{T1} = F_T\ (0.7R_T + l - c)$$

($l = 0$ in a circular ladle)

(2). Top rib at cross axis, 90 degrees from trunnion axis:

$$M_{T2} = -(F_T)0.3R_T$$

(3). Bottom rib at cross axis, 90 degrees from trunnion axis:

$$M_{B2} = (-F_B)0.3R_B$$

H. Normal stresses are not to exceed 16,000 psi and are to be calculated at each of the locations listed, as follows:

(1). Top rib above trunnion:

$$\text{(outside)}\ f_o = -\frac{M_{T1}}{S_{TO}}$$

$$\text{(inside)}\ f_i = +\frac{M_{T1}}{S_{TI}}$$

(2). Top rib at cross axis:

$$\text{(outside)}\ f_o = -\frac{F_T}{A_T} - \frac{M_{T2}}{S_{TO}}$$

$$\text{(inside)}\ f_i = -\frac{F_T}{A_T} + \frac{M_{T2}}{S_{TI}}$$

(Note: S_{TO} and S_{TI} may be different at locations 1 and 2 if rib varies in cross-section)

(3). Bottom rib at cross axis:

$$\text{(outside)}\ f_o = -\frac{F_B}{A_B} - \frac{M_{B2}}{S_{BO}}$$

$$\text{(inside)}\ f_i = -\frac{F_B}{A_B} + \frac{M_{B2}}{S_{BI}}$$

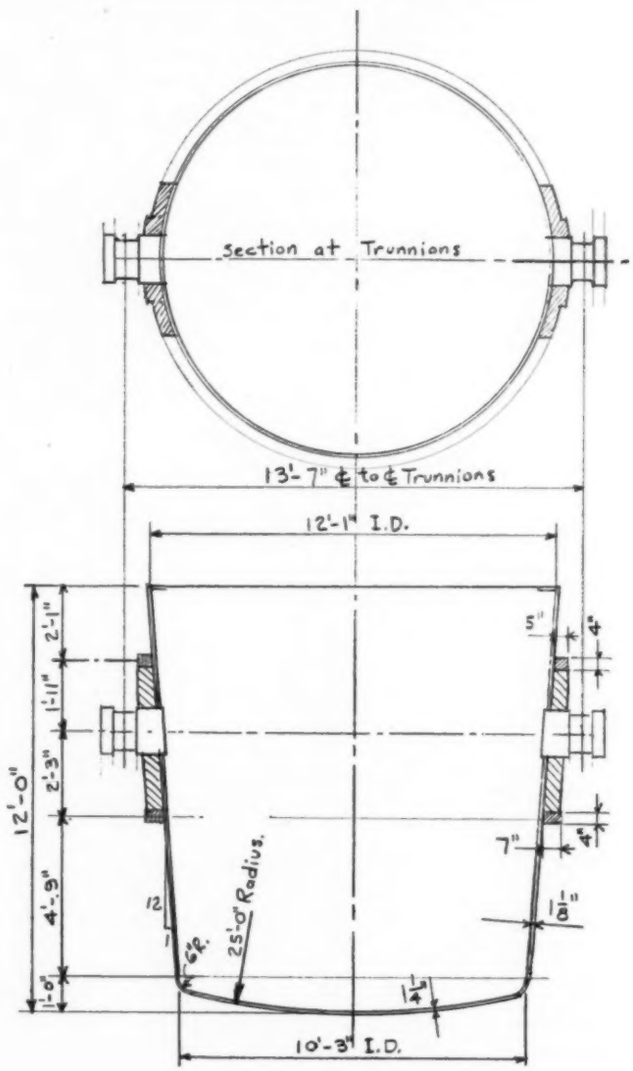
9. DESIGN OF SIDEWALL PLATES

A. The main sidewall thickness shall not be less than given by the following table:

Ladle capacity, tons	*Sidewall thickness, in.*
10	1/2
20	5/8
50	3/4
75	7/8
100	1
150	1 1/8
200 and up	1 1/4

For intermediate capacities, sidewall thicknesses may be interpolated to nearest 1/16 in. Between the ladle bottom and the bottom rib, the sidewall thickness should preferably be the same as the bottom plate thickness. In the case of flanged bottom plates (Section 4B), sidewall thickness may be less than the bottom plate thickness, but in no case shall the side plate thickness be less than 0.75 times the bottom plate thickness.

Figure 5 — Sketch gives dimensions for ladle used in sample numerical calculation in Appendix A.



APPENDIX A
Illustrative Design Example

These computations cover only the general features of the design. It is assumed that careful attention will be given to all details with proper grooves and welds provided to join all parts into an integral weldment.

General Dimensions determined by 150-ton capacity as shown in Fig. 5.

Estimated Weight

Metal	300,000 Lb.
Ladle	57,000
Lining	48,000
Total "W"	405,000 Lb.

Bottom Plate (See Section 7-B for dished bottom)

H = 144 In.
R = 300 In. (Arbitrarily selected standard)
r = 62 In. (Based on preliminary estimate of t=1")
Reqd. bottom plate thickness by 7-B

$$T = \frac{\left[15.2 + 0.60\times 144\left(0.1 + \frac{62}{300}\right)\right]300}{10{,}000} = 1.25 \text{ In.}$$

Use $1\frac{1}{4}$" Bottom Plate = 1.25 In.

Alternate Flat Bottom Plate Design

See Section G-B D = 2r = 124 In.
Reqd thickness for single plate

$$T = \frac{124\sqrt{144}}{625} = 2.38 \text{ In.}$$

Too thick for flanging - Use double plate - Sect GD

$$T_B + T_R = \frac{124\sqrt{144}}{510} = 2.92 \text{ In. Required.}$$

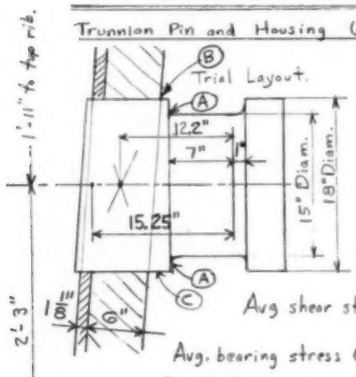
Use $1\frac{1}{2}$" Bottom Plate = 1.50 In.
$1\frac{7}{16}$" Reinforcing " = 1.44 In.
Total 2.94 In. furnished

By Sect. GC, reinforcing plate must have a diameter not less than 0.88 × 124 = 109 In.

Sidewall (Section 9A) $1\frac{1}{8}$" Required for 150 ton ladle

Minimum $t = 0.75 \times 1.25 = 0.94$ in. for dished bottom.
$t = 0.75 \times 1.50 = 1.125$ in. for flat bottom.
Use $1\frac{1}{8}$" thick sidewall

Trunnion Pin and Housing (Section 5E and 5F)



Try 15" pin diam.
Area = 176.7 In.²
Section Modulus = $\frac{\text{Area} \times \text{radius}}{4} = \frac{176.7 \times 7.5}{4}$ = 331 In.³
Normal stress due to bending at (A)

$$f = \frac{7 \times 202{,}500}{331} = 4{,}290 \text{ psi.}$$

O.K. See 8E allows 8000psi

Avg shear stress = $S = \frac{202{,}500}{176.7} = 1{,}150$ psi.

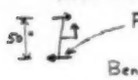
GE - See 8E allows 2400psi

Avg. bearing stress (Sect. 5F) at (B)

$$f_B = \frac{405{,}000}{2 \times 18 \times 7.125}\left[1 + \frac{6 \times 12.2}{7.125}\right] = 17{,}850 \text{ psi.}$$

O.K.

℄ Bottom Rib.
Ribs are 50" C-C.

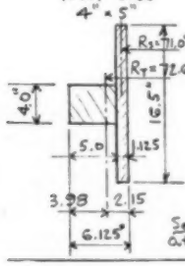


Force transmitted locally to rib = $\frac{202{,}500 \times 12.2}{50} = 49{,}400$ Lb.
Bending Moment at (C) = 49,400 × (27-8) = 890,000 Lb In.
Using a 6" × 28" inside pad welded to $1\frac{1}{8}$" sidewall,
Section Modulus = $\frac{28 \times 7.125^2}{6} = 236.5$
Stress due to bending in pad = $\frac{890{,}000}{236.5} = 3{,}760$ psi
OK

Stiffener Ribs (Section 8)

Effective Rib Properties.

Top Rib.
Trial size 4" × 5"



R_S = 71.0"
Effective shell (Sect 8c)
$b_e = 4.0 + 1.4\sqrt{71.0 \times 1.125} = 16.5$"

Locate N.A.

16.5 × 1.125 =	18.58	× 0.562 =	10.46
5.0 × 4.0 =	20.00	× 3.625 =	72.5
Area =	38.58		82.96

÷ 38.58 = 2.15

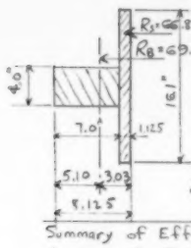
Moment of Inertia

$$\frac{1}{12}(18.58 \times 1.125^2 + 20 \times 5^3) = 43.6$$
$$18.58 \times 1.59^2 + 20.0 \times 1.48^2 = 90.9$$
$$I_T = 133.5 \text{ in}^4$$

Section Moduli:
Outside $S_{TO} = \frac{133.5}{3.98} = 33.6$ in.³ $S_{TI} = \frac{133.5}{2.15} = 62.1$ in.³

Bottom Rib. $R_S = 66.8$"

$$b_e = 4.0 + 1.4\sqrt{66.8 \times 1.125} = 16.1\text{"}$$



Locate N.A.

16.1 × 1.125 =	18.1	× 0.562 =	10.2
7.0 × 4 =	28.0	× 4.625 =	129.5
Area =	46.1		139.7

÷ 46.1 = 3.03

Moment of Inertia

$$\frac{1}{12}(18.1 \times 1.125^2 + 28 \times 3.5^2) = 116.2$$
$$18.1 \times 2.47^2 + 28 \times 1.06^2 = 182.2$$
$$I_B = 298.4 \text{ in}^4$$

Section Moduli:
$S_{BO} = \frac{298.4}{5.10} = 58.6$ $S_{BI} = \frac{298.4}{3.03} = 98.6$

Summary of Effective Rib Properties.

$A_T = 38.6$ in² $I_T = 133.5$ in⁴ $S_{TO} = 33.6$ in³ $S_{TI} = 62.1$ in³ $R_T = 72.6$" $h_T = 10.7$"
$A_B = 46.1$ in² $I_B = 298.4$ in⁴ $S_{BO} = 58.6$ in³ $S_{BI} = 98.6$ in³ $R_B = 69.3$" $h_B = 5.7$"

Rib Forces (Section 8E)

From Fig. 5 $\alpha = 163°$ $R_M = 67.6$"

$$C = \frac{298.4 \times 57 \times \sqrt{72.6^3}}{133.5 \times 107 \times \sqrt{69.3^3}} = 1.37$$

Top Rib $F_T = \frac{405{,}000(163 - 1.27 \times 67.6)}{8(1.37 \times 57 + 107)} = 21{,}050$ Lb.

Bottom Rib: $F_B = 1.37 \times 21{,}050 = 28{,}850$ Lb

Rib Moments (Section 8G)

① Top Rib, adjacent to trunnion pad

$$M_{T1} = 21{,}050[0.7 \times 72.6 - 14]^* = 775{,}000 \text{ Lb. In.}$$

② Top Rib, 90° from trunnion axis.

$$M_{T2} = -21{,}050 \times 0.3 \times 72.6 = -459{,}000 \text{ Lb. In.}$$

③ Bottom Rib, 90° from trunnion axis.

$$M_{B2} = -28{,}850 \times 0.3 \times 69.3 = -600{,}000 \text{ Lb. In.}$$

Normal Stress in Ribs due to Bending and Direct Force (From Sec 8H)

At ①
$$f_o = -\frac{775{,}000}{33.6} = -23{,}000 \text{ psi}$$
$$f_i = +\frac{775{,}000}{62.1} = +12{,}500 \text{ psi}$$

At ②
$$f_o = -\frac{21{,}050}{38.6} + \frac{459{,}000}{33.6} = +13{,}100 \text{ psi}$$
$$f_i = -\frac{21{,}050}{38.6} - \frac{459{,}000}{62.1} = -7{,}950 \text{ psi}$$

At ③
$$f_o = -\frac{28{,}850}{46.1} + \frac{600{,}000}{58.6} = +9{,}600 \text{ psi}$$
$$f_i = -\frac{28{,}850}{46.1} - \frac{600{,}000}{98.6} = -6{,}700 \text{ psi}$$

Top Rib overstressed. →

Possible solutions.
① Increase top rib section, or
② " bottom " " , or
③ Add additional section near trunnion

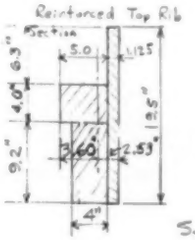
* In case of oval ladle be sure to add "l" as per section 18G.

Increase Top Rib Section at Trunnion

Use two - 4"×18" pads on each side of 6"×28" pads

Effective Width (Sect. 8c)
$b_e = b_T + b_1 + b_2$
$b_T = 4.0$"
$b_1 = 0.4\sqrt{71.0 \times (5.125 + 2.25)} = 9.2$"
$b_2 = 0.7\sqrt{71.0 \times 1.125} = 6.3$"

Reinforced Top Rib Section



Locate N.A.

19.5 × 1.125 =	21.9	× 0.562 =	12.3
9.2 × 4.0 =	36.8	× 3.125 =	115.0
5.0 × 4.0 =	20.0	× 3.625 =	72.5
Area =	78.7		199.8

÷ 78.7 = 2.53

Moment of Inertia

$$\frac{1}{12}(21.9 \times 1.125^3 + 36.8 \times 4^3 + 20 \times 5^3) = 92.8$$
$$21.9 \cdot (1.81)^2 + 36.8 \cdot (0.28)^2 + 20 \cdot (1.78)^2 = 122.4$$
$$215.4$$

$$S_{TO} = \frac{215.4}{3.60} = 59.7$$

Stress, outside, at ① = $\frac{775{,}000}{59.7} = 13{,}000$ psi.

Also check stress at location ④

$$M = 21{,}050[0.7 \times 72.6 - 26] = 523{,}000 \text{ Lb. In.}$$

Stress at ④ $f = \frac{523{,}000}{33.6} = 15{,}500$ psi

All rib stresses now O.K.

APPENDIX B
BASIS AND EXPLANATION OF THE SPECIFICATION

This specification on Design of Hot Metal Ladles is based on an extensive program of research sponsored and financed by the Association of Iron and Steel Engineers at the Fritz Engineering Laboratory of Lehigh University at Bethlehem, Pa. In this research program, model test ladles were loaded and the stresses measured at various points in the ladle. The ladles were then analyzed by mathematical methods. The ladle models were scale models of various types in actual service. Primary attention in the analysis was given to the stiffening rings and trunnion assembly.

Guiding this work was a committee composed of steel mill engineers, ladle manufacturers, representatives of Lehigh University and the Association of Iron and Steel Engineers. Credit is due this entire group for directing the research work into channels which have resulted in a relatively simple, practical specification which is of value to the steel industry.

The committee to whom this credit is due consists of the following men:

F. E. Kling (*chairman*), Tenafly, N. J.

Leo J. Gould, Chief Engineer of Construction, Bethlehem Steel Co., Bethlehem, Pa.

H. A. Leermakers, Building Engineer, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

William H. Mursch, Staff Engineer, U. S. Steel Co., Pittsburgh, Pa.

Leonard Larson, Chief Engineer, Corrigan-McKinney Plant, Republic Steel Corp., Cleveland, Ohio.

F. L. Lindemuth, Chief Engineer, William B. Pollock Co., Youngstown, Ohio.

H. L. McFeaters, Chief Engineer, Pennsylvania Engineering Corp., New Castle, Pa.

W. W. Wallace, Treadwell Engineering Co., Pittsburgh, Pa.

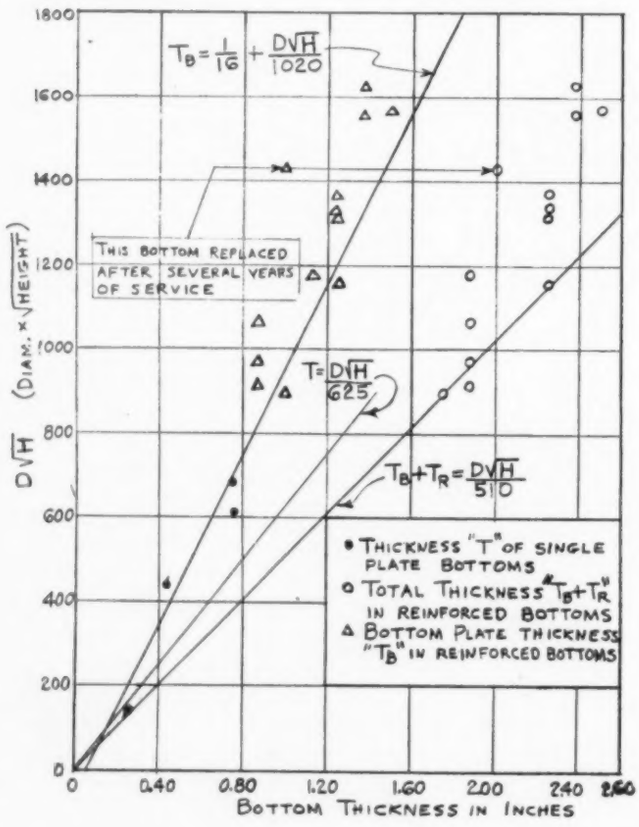
I. E. Madsen, Standards Engineer, Association of Iron and Steel Engineers, Pittsburgh, Pa.

Bruce G. Johnston, Professor of Structural Engineering, University of Michigan, Ann Arbor, Mich., formerly Director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

K. E. Knudsen, Research Engineer, Lehigh University, Bethlehem, Pa.

Wm. M. Munse, Research Engineer, Lehigh University, Bethlehem, Pa.

Figure 6 — Sketch shows comparison between design requirements and a number of existing circular flat bottom ladles.



The proposed formulas were based on theoretical considerations and allowable unit stresses modified according to the state of stress in the member and its reserve strength. The goal has been to achieve the maximum simplicity possible, consistent with safety and economy.

The results of this study indicate that ladles are in general well-designed as they are now manufactured, irrespective of whether or not a great amount of analysis was carried out as a preliminary. Many years of trial and error have evolved good proportions. The design formulas of the specification yield proportions similar to those now obtained in practice. One of the purposes of this appendix is to show to what extent this is the case. However, the design formulas were *not* arrived at by working backward from existing practice, but as mentioned before are based on theoretical considerations.

The procedure for calculating maximum stresses in the stiffening ribs is a simplification and revision of the method previously proposed as a result of the research carried out at the Fritz Engineering Laboratory of Lehigh University.(1) The agreement between the design procedure and experimentally measured stresses is even better than in the earlier more complicated procedure, especially with respect to the more critical stresses.

The following paragraphs will be numbered to correspond to the numbering in the body of the specification. No discussion is offered with respect to Sections 1, 2 and 3, which are self-explanatory.

4. DETAILS OF CONSTRUCTION

The recommendations in this section are based on accepted good practice in ladle design and in large part these are drawn verbatim from a previously proposed specification.(2) Reference (1) also reviews these and other related recommendations.

(1) KNUDSEN, K. E., MUNSE, WM. M., and JOHNSTON, B. G., "*Stresses in Hot Metal Ladles*," Iron and Steel Engineer, Vol. XXVI, No. XII, December, 1949, pp. 49-70.

(2) "*Tentative Specifications for Hot Metal Ladles*," Carnegie-Illinois Steel Corp., Senior Staff Engineering Bureau, No. 7, Pittsburgh, Pa., December 2, 1948.

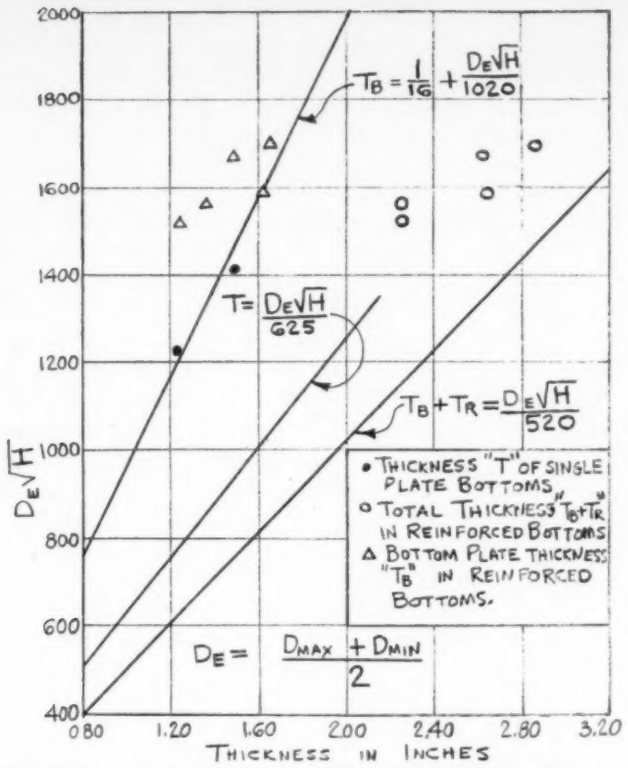


Figure 7 — Sketch shows comparison between design requirements and a number of existing oval flat bottom ladles.

5. DESIGN STRESSES AND DESIGN ASSUMPTION

C. a. The lowest permissible stresses (8000 psi) are listed for cases where the stress is uniform or nearly so throughout the thickness of material, and in cases where initial yielding would be followed by large deformations.

C. b. The stress in the ladle rib is primarily bending and the ribs are usually rectangular in shape. After initial yielding in bending for such a shape, there is still considerable reserve strength before yielding is completely general throughout. Therefore, an allowable stress of 16,000 psi is used. Furthermore, yielding in one place will be followed by a redistribution of stress and will not be indicative of early failure. This is the basis for permitting a higher allowable stress in the elastic range since the real factor of safety of the structure is greater than indicated by the nearness of the allowable stress to the yield point.

The same reasoning applies to bending in the flat bottom plates, and there is the additional factor that as a flat bottom yields, it becomes dished and starts to take still more load through direct membrane stresses that are developed. The recommended allowable stresses, nevertheless, are within the elastic range of the material.

C. c. In this class (24,000 psi) are the stresses, such as concentratons near a sharp fillet or hole, that in themselves do not effectively help carry the load. They are to be considered only on a secondary basis as a possible indication of danger to brittle failure from fatigue or other cause. In a dished bottom, the load is carried by the membrane stresses and the local bending stresses at the boundary are put in this class. Initial yielding due to these stresses in itself has practically no effect on the general structural behavior.

6. DESIGN OF BOTTOM PLATES OF FLAT BOTTOM LADLES

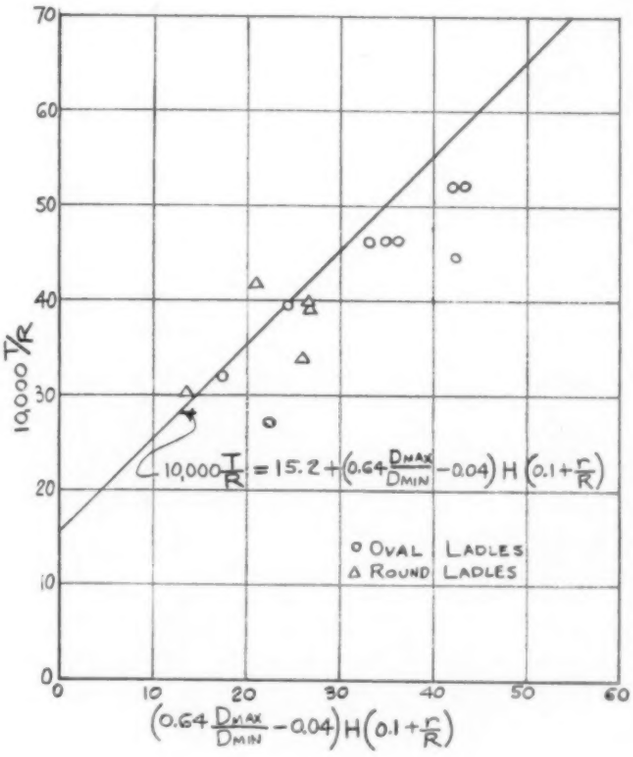
The formulas given herein for thickness of flat bottom plates have been arrived at on the basis of the bending theory of circular plates, considering the restraint of the sidewalls as being intermediate between simple supports and fully fixed edges.

Figure 6 shows the agreement for circular bottom ladles between the proposed design formulas and a number of ladles built by various manufacturers over a period of many years. The design formulas give thicknesses on the safe side of existing practice.

Figure 7 is similar to Figure 6, but is for oval bottom ladles, and is based on an "equivalent" diameter as given in Section 6F. "Oval" ladles usually have flat sides at the minimum diameter, joined by circular sections. Their shape is not greatly different from an ellipse. A study of the bending of elliptical plates, together with consideration of the fact that the flat portions of the ladle sidewalls offer much less bending restraint than the circular sections, showed that an "equivalent" diameter equal to the average of the maximum and minimum diameters could be used in the empirical formulas of Sections 6B and 6D.

The greatest discrepancy between the proposed design formulas and existing practice appears to be in the case of the flat bottoms with no reinforcing plates. These are used only for relatively small capacity ladles and only a few designs were available for this comparison. Bottom plate thicknesses in these cases would have had to be appreciably thicker if the present specification had been applied.

Figure 8 — Sketch shows comparison between design requirements and a number of existing dished bottom ladles.



7. DESIGN OF BOTTOM PLATES OF DISHED BOTTOM LADLES

The formulas for thickness of dished bottom ladles, as given in Section 7, were obtained by a theoretical analysis of the local bending stresses at the juncture between the ladle bottom and sidewall. Since these stresses are highly localized, and since the load is carried not by bending but by direct stress, an allowable stress of 24,000 psi, as explained in Section 5, was permitted.

The initial formulas resulting from this analysis were quite complex. Simplifications were introduced so that the resulting empirical formulas, as given in Sections 7B and 7C, for circular and oval ladles respectively, would give proportions on the safe side.

In Figure 8 the thicknesses required by the empirical formula are compared with a number of actual ladle designs. The dimensionless ratio 10,000 T/R is plotted as ordinate against the dimensionless ratio appearing on the right side of the proposed empirical formula (Section 7C). Of the fourteen designs considered, only two have thicker bottom plates than would result from the specification formula. The remainder, however, are still in reasonably good agreement and show the same trend as the solid line plotted from the formula.

8. DESIGN OF STIFFENER RIBS

The notation used in the rib analysis and design has been given in Figures 1 to 4, and the design procedure illustrated in Appendix A for the ladle shown in Figure 5.

TABLE I

STRESSES IN TEST LADLE A

(Round, Riveted, with Flat Stiffener Bands)

Location			2½-in. Hook distance, 8 x 8-in. trunnion pads		2½-in. Hook distance, 8 x 16-in. trunnion pads		7½-in. Hook distance, 8 x 16-in. trunnion pads	
			Test	Formula	Test	Formula	Test	Formula
Lip ring	0°	Outside	—10,800	—10,900	— 6,850	— 8,750	—12,200	—14,300
		Inside	+28,400	+25,900	+23,400	+20,750	+33,600	+34,000
	90°	Outside	+ 4,880	+ 5,400	+ 4,010	+ 5,400	+ 7,730	+ 8,900
		Inside	—15,500	—14,200	—17,990	—14,200	—29,770	—23,400
Top rib	0°	Outside	— 6,450	— 7,300	— 2,180	— 5,900	— 4,360	— 9,700
		Inside	+ 3,500	+ 5,600	+ 1,600	+ 4,400	+ 3,400	+ 7,300
	90°	Outside	+ 3,740	+ 3,800	+ 3,450	+ 3,800	+ 5,570	+ 6,300
		Inside	— 1,820	— 3,000	— 2,010	— 3,000	— 3,120	— 4,900
Bottom rib	90°	Outside	+ 4,600	+ 3,100	+ 4,220	+ 3,100	+ 7,570	+ 5,200
		Inside	— 1,340	— 2,700	— 1,910	— 2,700	— 4,150	— 4,400

TABLE II

STRESSES IN TEST LADLE B

(Oval, Welded, Uniform Sidewall Thickness)

Location			2½-in. Hook distance		7½-in. Hook distance	
			Test	Formula	Test	Formula
Lip ring	0°	Outside	.....	—10,260	.....	—17,500
		Inside	+ 9,160	+13,200	+18,100	+22,600
	90°	Outside	+ 2,750	+ 4,260	+ 5,800	+ 7,270
		Inside	— 6,330	— 5,950	— 7,580	—10,130
Top rib	0°	Outside	— 9,970	—11,000	—22,400	—18,800
		Inside	+ 3,620	+ 5,580	+ 6,900	+ 9,500
	90°	Outside	+ 3,390	+ 4,560	+ 6,450	+ 7,790
		Inside	— 1,880	— 2,600	— 4,220	— 4,430
Bottom rib	90°	Outside	+ 4,290	+ 4,600	+ 8,500	+ 7,850
		Inside	— 3,310	— 3,700	— 6,060	— 6,320

Tables I, II, and III show a comparison of the maximum stresses actually measured in model ladles, as reported in Reference (1), with the stresses obtained by the procedure given in Section 8. A study of these tables will show that reasonably good agreement exists between stresses by analysis and test, especially in the case of the most critical maximum stresses.

The proposed analysis procedure was also tried out on five actual designs selected to cover a wide range of ladle capacity, from 70 to 270 tons. Most of the stresses so calculated, as shown in Table IV, were below the proposed allowable value of 16,000 psi. However, two of the ladles, designated in the table as made by "C", had top rib sections markedly reduced for hook clearance at the critical section, with stresses in this location in the neighborhood of the yield strength of structural grade steel. It is also of interest that this manufacturer has reported actual yielding of ladles in service at this location.

In Section 8G, no computation is required for the bottom rib at the trunnion, since the ladle research program showed these stresses to be less than at the other locations. In addition, the bottom rib is sometimes strengthened here to enable the ladle to be set in a ladle stand seat. However, good practice usually dictates that the lower ring be as large if not larger than the top ring, and that it be fully as large if not larger at the trunnion than at 90 degrees from the trunnion. The lip ring is not considered in the specification, since it is felt that the ladle should be strong enough without the

TABLE III

STRESSES IN TEST LADLE C

(Round, Welded, Sidewall Thickened Between Ribs)

Location			2½-in. Hook distance		7½-in. Hook distance	
			Test	Formula	Test	Formula
Lip ring	0°	Outside	— 9,150	— 9,350	—18,500	—15,430
		Inside	.....	+12,460	.....	+20,580
	90°	Outside	+ 3,540	+ 5,420	+ 6,020	+ 8,960
		Inside	— 5,930	— 7,230	— 9,500	—11,920
Top rib	0°	Outside	— 3,100	— 4,220	— 6,740	— 6,960
		Inside	+ 3,700	+ 3,600	+ 7,300	+ 5,950
	90°	Outside	+ 5,250	+ 7,290	+ 9,250	+12,030
		Inside	— 3,400	— 3,610	— 5,700	— 5,960
Bottom rib	90°	Outside	+ 4,180	+ 4,140	+ 4,430	+ 6,840
		Inside	— 2,340	— 2,070	— 4,430	— 3,420

TABLE IV

STRESSES BY PROPOSED DESIGN METHOD FOR VARIOUS FULL SIZE LADLES

			Actual ladle designs in service					Sample design example
Ladle mfg.			C	C	A	B	A	
Ladle capacity in tons			70	140	200	225	270	150
Top rib	0°	Outside	—39,000	—36,400*	**	—16,750	**	—13,500
		Inside	+19,700	+19,000	**	+10,300	**	+ 8,130
	At change of section	Outside	.....	.....	—15,600	—12,100	—16,700	—15,500
		Inside	.....	.....	+10,000	+ 6,500	+10,600	+ 8,400
	90°	Outside	+16,000	+ 5,540	+ 7,800	+13,800	+ 4,600	+13,100
		Inside	— 9,200	— 4,010	— 5,900	— 7,550	— 3,650	— 7,950
Bottom rib	90°	Outside	+10,500	+ 4,250	+ 6,100	+ 8,900	+ 4,800	+ 9,600
		Inside	— 6,800	— 3,230	— 4,700	— 5,500	— 3,450	— 6,700

*Section was reduced for hook clearance.

**Stress obviously greater at change of section.

lip ring, which may in practice be weakened by spouts or hot metal spills.

9. DESIGN OF SIDEWALL PLATES

Minimum sidewall thicknesses are in accordance with usage requirements, and in addition it is specified that the sidewall thicknesses shall not be less than 0.75 times the bottom plate thickness. This last requirement is set up to provide adequate restraint or fixity to the edge of the bottom plate.

CONCLUSION

Simplified design and analysis procedures for open top hot metal ladles have been presented and the results compared with laboratory tests and actual design practice. Reasonably good agreement has been found in each case. Generally accepted rules of good practice have been incorporated into the specification, as a result of suggestions by the Hot Metal Ladle Committee of the Association of Iron and Steel Engineers. Preliminary drafts of the specification, later revised by the committee, were prepared by Dr. Bruce G. Johnston, Professor of Structural Engineering, at the University of Michigan. The formulas for dished bottom shell thickness in Section 7 were prepared by Dr. Bruno Thurlimann, former research worker in the field of thin shell structures at Fritz Engineering Laboratory of Lehigh University.

AISE HOT METAL LADLE SPECIFICATION

PURCHASER'S INFORMATION SHEETS

.....Company
.....Works

Located at .....
Specification No. ..... Dated .....

.....TON HOT METAL LADLE

(This information to be furnished bidder by purchaser)

1. The following specific information, together with the AISE Standard No. 9, Specifications for Design of Hot Metal Ladles, dated ....., shall form the complete specifications of number as noted above.
2. Contractor shall furnish .....
   .....
   .....
   as covered by these specifications.
3. Ladle to be delivered F.O.B. .....
4. Number of sets of prints, etc., to be furnished:
   Specifications .....
   Are prints or tracings required? .....
5. Required delivery date is .....

GENERAL DETAILS

6. Capacity of ladles is ..... tons.
7. Material which ladle will handle is .....
8. Weight of molten metal to be handled is ..... lb per cu ft.
9. Maximum allowable weight of ladle will be ..... lb.
10. Limiting height of ladle is ..... ft ..... in.
11. Limiting diameter of ladle is ..... ft ..... in.
12. Centerline of trunnion to top of lining flange shall not exceed ..... ft ..... in.
13. Centerline of trunnion to underside of bottom shall not exceed ..... ft ..... in.
14. Inside diameter of ladle at top shall not exceed ..... ft ..... in.
15. Thickness of ladle hooks is ..... in.
16. Diameter of trunnions will be as follows: .....
17. Distance between centerlines of trunnions and ladle hooks is ..... ft ..... in.
18. Side hook loops are required as follows: .....
    .....
    .....
19. Ladle stand seat is required as follows: .....
    .....
    .....
    .....
20. Is a heat shield required on bottom? .....
21. Stopper rod rigging will be as follows: .....
    .....
    .....

22. Location of teeming spout will be as follows:
23. Diameter of tap hole will be as follows:
24. Location and number of pouring lips will be as follows:
25. Painting required is as follows:

26. Protection of finished parts for shipment will be as follows:

27. Ladle will be unloaded by
28. (See 3 A, a) material for bottom plate will be
29. (See 3 A, b) material for shell plate stiffener rings, etc., will be

30. (See 3 A, f) the lining shall be composed of the following:

31. Lining will be furnished by
32. (See 4 B) Bottom plate will be dished ..... or flat ..... as checked.
33. Ladle will be welded ..... or riveted ..... as checked.
34. (See 4 F) Are steel bushings required for trunnions?
35. (See 4 F) Are oilless bronze bushings required on the trunnion pin?
36. (See 4 I) Are heat protection plates required around pouring nozzle?
37. (See 4 K) Are weep holes required on side of ladles?

SPECIAL FEATURES

ASSOCIATION OF IRON AND STEEL ENGINEERS STANDARDS

AISE Standard No. 1 — D-C MILL MOTOR STANDARDS	$0.25 ea
AISE Standard No. 2 — STANDARD DIMENSIONS FOR ENCLOSED SWITCHES	0.25 ea
AISE Standard No. 3 — STANDARDS FOR MACHINED SURFACE FINISHES	0.25 ea
AISE Standard No. 4 — SLING AND CRANE CHAIN STANDARDS	0.25 ea
AISE Standard No. 5 — STANDARDS FOR WIRING DIAGRAMS	0.25 ea
AISE Standard No. 6 — SPECIFICATIONS FOR ELECTRIC OVERHEAD TRAVELING CRANES FOR STEEL MILL SERVICE	1.00 ea
AISE Standard No. 7 — SPECIFICATIONS FOR DESIGN OF LADLE HOOKS	0.25 ea
AISE Standard No. 8 — CRANE WIRING STANDARDS	0.25 ea
AISE Standard No. 9 — STANDARDS FOR DESIGN OF HOT METAL LADLES (Tentative)	0.25 ea
AISE Standard No. 10 — CARBON BRUSH SIZE AND SHUNT STANDARDS (Tentative)	0.25 ea
AISE Standard No. 11 — D-C MILL MOTOR BRAKE STANDARDS (Tentative — In Process)	0.25 ea

RECOMMENDED PRACTICES

AISE Recommended Practice No. 1 — PLAIN BEARING RECOMMENDED PRACTICE (Tentative)	1.00 ea

Quantity prices may be obtained on request.

Minimum price for any order $1.00.

Over 600 **POLLOCK** welded Open Hearth ladles in capacities ranging from 15 to 300 tons are being used by major steel companies in the United States and Canada.

The welded ladle was introduced by **POLLOCK** in 1932 and the advantages over heavier, riveted types were recognized immediately.

Lighter weight and smoother inside and outside surfaces add to their importance.

POLLOCK welded ladles are custom designed to suit existing plant conditions. Construction details of spouts, stopper holes, stopper riggings, etc., are detailed to meet specific requirements.

POLLOCK
Since 1863
BLAST FURNACES • HOT METAL CARS AND LADLES
CINDER AND SLAG CARS • INGOT MOLD CARS
CHARGING BOX CARS • WELDED OPEN HEARTH LADLES

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO
STEEL PLATE CONSTRUCTION • ENGINEERS
FABRICATORS • ERECTORS

PENNSYLVANIA ENGINEERING CORP.

NEW CASTLE, PENNA.

LADLES

WELDED OR RIVETED

5 TO 300 TON CAPACITY

FOR

BLAST FURNACE

OPEN HEARTH

ELECTRIC FURNACE

BESSMER CONVERTER

FOUNDRY

LADLE TRANSFER CARS

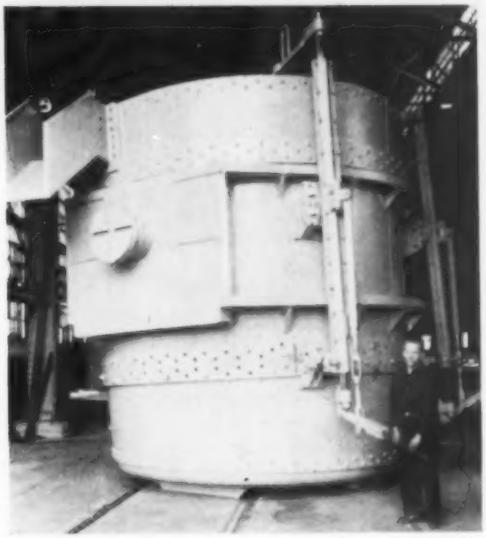
LADLE STANDS

LADLE BAILS

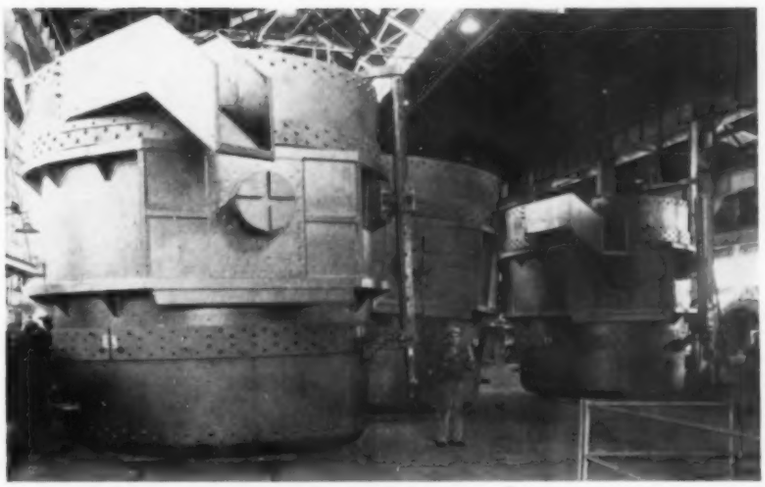
LADLE HOOKS

ALL WELDED LADLES

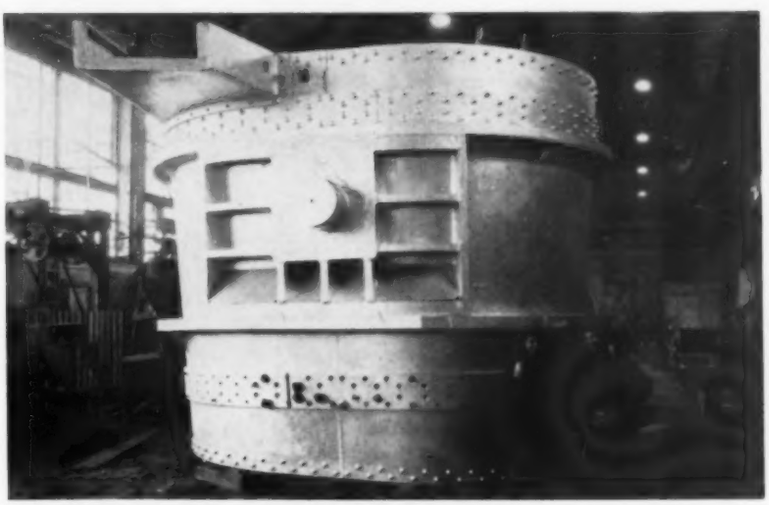
STRESS RELIEVED



225 TON LADLE



250 TON LADLE



300 TON LADLE

DESIGNERS, FABRICATORS AND ERECTORS OF STEEL MILL EQUIPMENT

TREADWELL

LADLES

HOT METAL

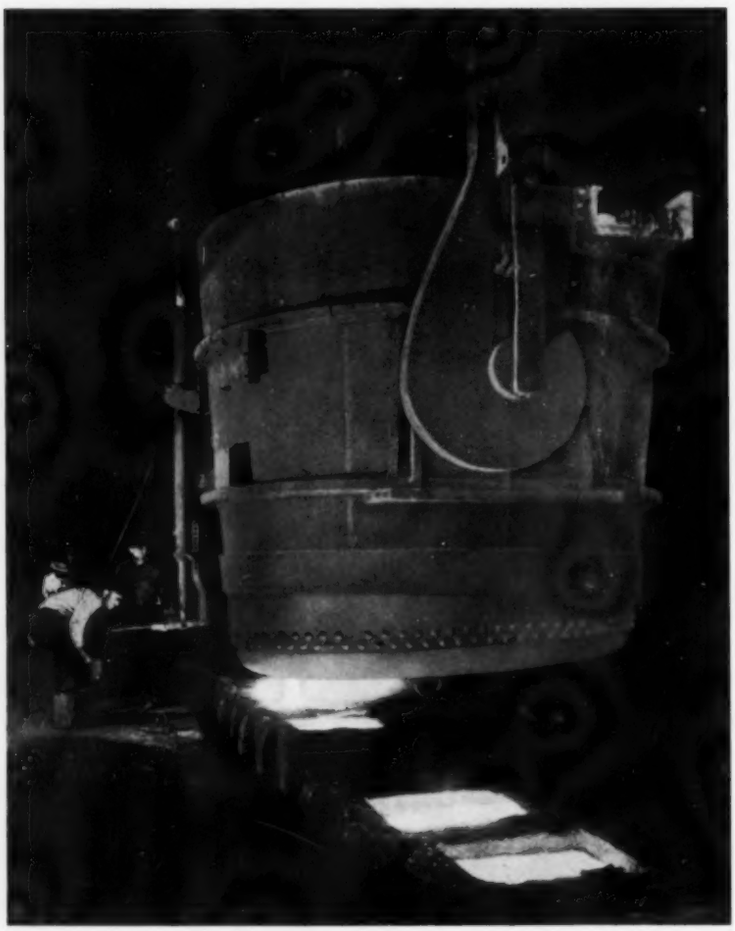
HOT METAL TRANSFER

BESSEMER

OPEN HEARTH

ELECTRIC FURNACE

FOUNDRY



WELDED and RIVETED for the STEEL COPPER BRASS ALUMINUM and ALLIED INDUSTRIES

TREADWELL CONSTRUCTION CO.

MIDLAND, PENNSYLVANIA

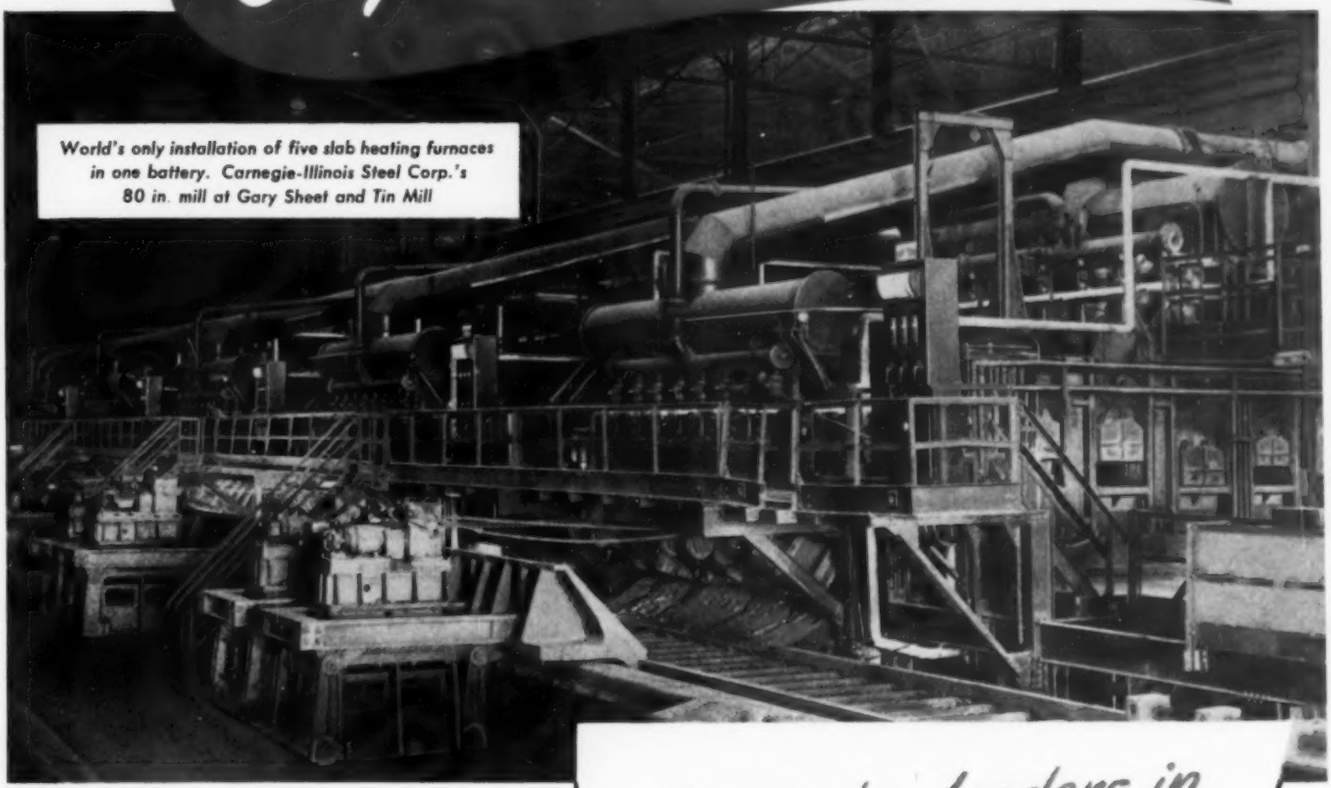
SALES OFFICES

208 S. LaSalle Street
CHICAGO 4, ILL.
CEntral 6-9784

140 Cedar Street
NEW YORK 6, N. Y.
WOrth 4-3344

1217 Farmers Bank Building
PITTSBURGH 22, PA.
ATlantic 1-2883

Only RUST has it *



World's only installation of five slab heating furnaces in one battery. Carnegie-Illinois Steel Corp.'s 80 in. mill at Gary Sheet and Tin Mill

* RUST (Patented) ZONE-FIRED CONTROL

. . . your assurance of 100% accuracy in the control of predetermined heating temperatures.

Rust gives you positive control of heating quality and tonnage output. Flexibility is achieved by simply changing rate of fuel fired. Unique design maintains constant soaking chamber heat for any specific rolling temperature . . . uniform heating efficiency with a minimum of fuel.

THE WHOLE JOB IS ONE JOB WITH A

RUST "PACKAGE" CONTRACT

ONE RUST CONTRACT covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including excavations, foundations, wiring and piping. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

No wonder Leaders in the Steel Industry use

RUST SLAB HEATING FURNACES

Because PERFORMANCE is so important, leading steel makers throughout the world use RUST patented, zone-controlled, double or triple-fired, recuperative, continuous furnaces. They are individually designed to reheat slabs, blooms, billets, bars and other shapes.

Nearly 200 Rust installations, ranging in capacity from 20 to 115 net tons per hour, represent more than one-third of the heating capacity (excluding soaking pits) of America's iron and steel industry. Present conditions call for utmost efficiency and economy in production. Time to consult Rust.

RUST FURNACE CO.

PIONEERS IN FURNACE DESIGN

PITTSBURGH, PENNSYLVANIA

Phone ATlantic 1-8870

F-1

WELDMENTS FIND INCREASED USE IN GEAR DRIVES

By C. J. SCHORSCH
Gear Proposal Engineer
United Engineering & Foundry Co.
Pittsburgh, Pa.

and

ROBERT HIRSCH
Welding Engineer
The Lincoln Electric Co.
Cleveland, Ohio

▲ Over a period of some twenty years, United Engineering & Foundry Co. gear drives have undergone substantial and significant changes both in design and construction, especially in respect to housings. The trend has been toward the use of more and more weldments and away from all-cast designs. This has occurred in several steps each of which was dictated by favorable experience gained by prior steps.

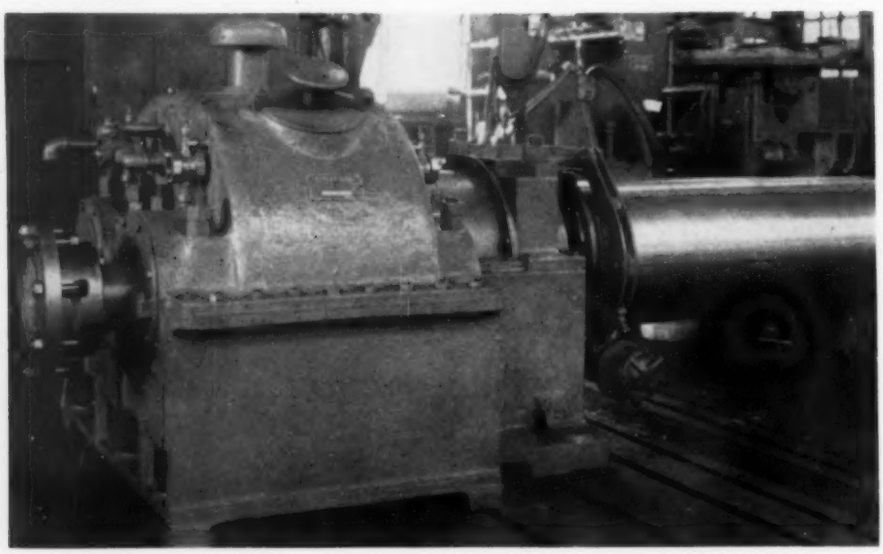
It was found in practice that several steel elements could be fused by arc welding into sturdy and rigid structures of dependable strength. Today, as a result of this experience, some gear drives even in quite large sizes have housings fabricated almost entirely from rolled steel components joined by such welding. In other cases some cast steel components are included in the housing, but these are joined to each other and to rolled steel components by arc welding.

In this process, gray iron castings have nearly disappeared and all sizable castings are of steel. Instead of making complete housings as large steel castings, however, two or more smaller steel castings are employed, especially as side frames, and then are combined along with such steel plate components as may be needed, into a main housing. Cover portions today are built up largely or wholly of rolled steel plate joined by arc welds.

This procedure has materially simplified foundry problems partly by saving the space and high cost of large molds and reducing the chances of imperfect castings that would either have to be scrapped or undergo expensive repairs to be made serviceable. With smaller castings, when they were still used, space requirements are smaller, patterns cost much less, sections can be more nearly uniform in wall thickness, and the chances of imperfect castings are materially reduced. Costs savings become important not only because of factors just mentioned, but also because total weight of the assembly can be less (since thinner sections can be used at most points), and also because, for a given total weight, rolled steel commonly costs much less per pound than cast steel.

Another significant consideration is that gear drives are commonly custom built and, in such cases, the welded design tends to be much less costly, partly because pattern costs (which are unusually high today) are either avoided as in a completely fabricated design or are greatly reduced because smaller patterns are needed for the fewer castings that are used. If several duplicate housings happen to be ordered or built at one time, the pattern charge per machine is lowered accordingly, although even then, the balance is likely to favor a combination of cast and rolled steel joined by welding as against all-cast construction.

Figure 1 — Reel drive of 400-hp capacity has an all-cast steel housing and cover. Equivalent drives built today employ few if any large castings, being produced as weldments with considerable reductions in cost and weight.



At United, experience has shown that the fundamental steps for a welded design are much simpler and more economical than for a cast design. The separate elements of the welded structure are easily visualized and strength analysis is far simpler and involves lower safety factors than for cast designs because no allowance for possible hidden flaws is required as for castings. Each component can be produced from materials having known composition and well established physical properties. Moreover, components are simpler for draftsmen to detail, hence less drafting time is chargeable to the job. There is also less paper work, especially where no patterns or castings are involved as fewer departments are involved.

Of still greater importance under some conditions is that if all parts are to be fabricated from plate or

The sword of CAESAR'S LEGIONS
Strong blades that won an empire

The swords of Caesar's legions were superior weapons. The Roman sword possessed a thick, heavy blade that was effective in delivering either a cutting or thrusting stroke . . . and, it could withstand battering against the armor of the enemy.

The Romans improved their knowledge of metallurgy from the nations they conquered. Roman swords were forged to the most exacting specifications of their time. They represented the best in efficiency and durability.

famous blades

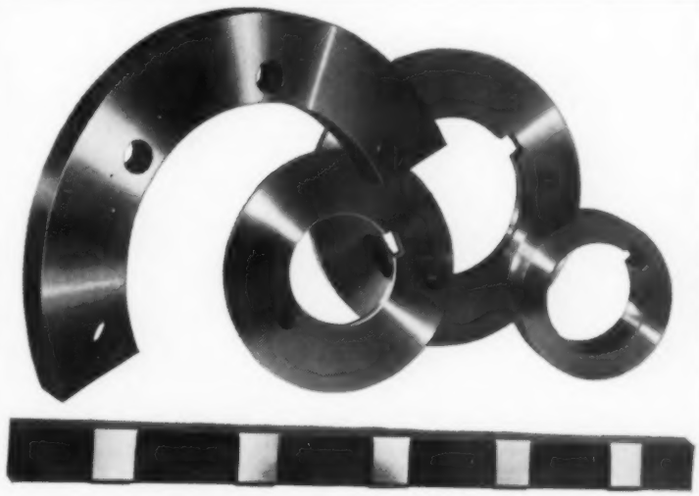
Heppenstall SHEAR KNIVES
Strong blades that win results for industry

Like the blades of ancient Rome, the modern Shear Knives made by Heppenstall are continually improved through technical development.

Users of Heppenstall Knives obtain exceptional service as represented by the following advantages:

- MORE CUTS BETWEEN GRINDS
- MORE UNITS PER BLADE
- LOWER OVERALL BLADE COST
- INCREASE IN PRODUCTION

Your shearing and trimming operations can also benefit through Heppenstall Shear Knives. Make them your standard specifications for increased efficiency and lower overall costs—today.



Heppenstall

the most dependable name in forgings

PITTSBURGH 1, PENNSYLVANIA

Sales offices in principal cities

Mr. William Hartfel, Chief Electrician
Trent Tube Mfg. Co., East Troy, Wisconsin
Division of Crucible Steel Co. of America

"By replacing ordinary fuses with Fusetron fuses

WE WIPED OUT NEEDLESS FUSE BLOWS

"We have a 1200 ampere switch with a grounded neutral on our 220 volt, 3 phase system. To handle the load of approximately 1000 amperes, we used two 600 ampere fuses in parallel.

"These fuses gave us a lot of trouble by blowing two or three times a week. Each blow meant a shutdown that caused a loss in production.

"In the early part of May, about two months ago, we decided to try out Fusetron dual-element fuses.

"These fuses completely wiped out needless fuse blows and what is more important they eliminated the costly interruptions of operating schedules."

Don't Risk Losses in Your Plant

One **needless** shutdown — One **lost** motor
One **destroyed** panel or switch
One **burned out** solenoid

May cost you more than replacing every ordinary fuse with a FUSETRON dual-element Fuse.

But, simply knowing that FUSETRON fuses do save money is knowledge — but it isn't action.

By passing the word along that all purchase and stock records should call for FUSETRON dual-element fuses, you have action that begets money saving.

IN A 1200 Amp. SWITCH

and stopped production shutdowns that had been occurring two or three times a week."

Fusetron DUAL ELEMENT Fuses

Provide NOT ONLY SHORT CIRCUIT *But* 10 Point Protection

1. Protect against short-circuits.*
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating—lesser resistance results in much cooler operation.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloading.
6. Protect motors against burnout due to single phasing.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Make protection of small motors simple and inexpensive.
9. Protect against waste of space and money — permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

*Fusetron fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

Send the Coupon for more facts

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division of McGraw Electric Co.)
Please send me complete facts about FUSETRON dual-element Fuses.

Name _____ Title _____

Company _____

Address _____

City & Zone _____ State _____ 352

(Fusetron is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

slab steel, designs can go directly to the fabricating shop without the delays and extra expenses of processing through pattern shop and foundry. Although some machining is commonly needed on portions of the weldments, total machining time is likely to be much less because it is not so difficult to hold to closer dimensions on a weldment than it is on a casting, and surfaces of the weldment are smoother and closer to true flatness; hence, the cuts required in machining are likely to be lighter and to involve less waste of metal than for castings.

Actual examples cited below support foregoing conclusions and make it clear that substantial economies, both in time and in material result from welded as opposed to all-cast construction. Precise savings are somewhat difficult to evaluate, partly because the older designs of all-cast type were produced when wage, overhead, and material costs were far below current levels. In one rough comparison of two designs, the first all-cast and the second fabricated by welding and built seventeen years later for substantially the same service, a saving of about 15 per cent in manufacturing time and in total cost of about the same percentage were realized. If the old design was to be built at today's high prices, there is no doubt that comparative savings favoring the welded product would be much more than this comparison indicates.

Experience at United, conservatively expressed and relating to the manufacture of custom built gear drives for the steel industry shows in general that welded housings are not only as satisfactory in service as are drives having all-cast housings, but costs as a rule are substantially less than for the latter.

Transition from all-cast to completely welded structures was not made in a single step. The first step was to use only a welded cover on an all-cast base. Another step was to employ cast side girders of channel section and cast bearing blocks, and to tie these together by welding them to a rolled steel base plate and to other plates to complete the frame enclosure. In this drive as in virtually all current designs, the cover is fabricated from relatively light gage steel plates. In some of these covers, one or more plates are formed to a curved contour to follow the general outline of the gear.

Welded construction similar to that just described is continued on some gear drives, especially of large size, partly because of the success attained with this construction over more than a decade. Cast side girders are not expensive, especially when existing pattern equipment can be used, and in some cases may cost less than equivalent structure built up by welding steel plates, even though castings are heavier. Each case may require analysis to determine whether or not cast girders offer cost savings or not.

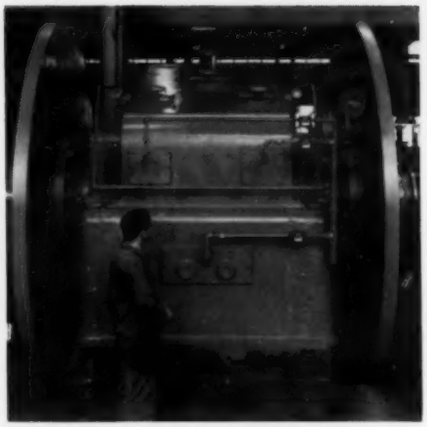


Figure 3 — In this gear drive for a 36 x 62-in. two-high mill, the main housing is a weldment, but includes cast steel side girders, the cover being of all welded plate.

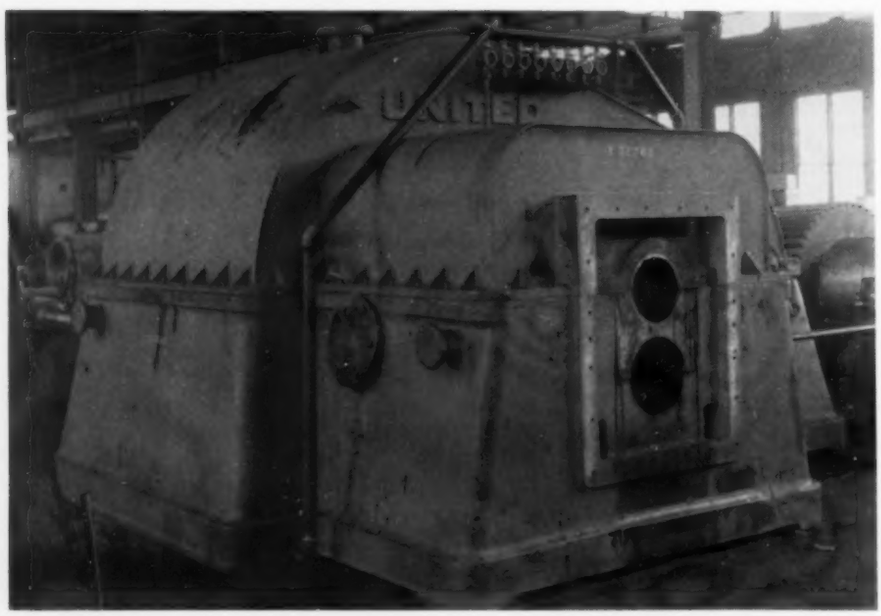
In many gear drives, there is a further reduction in foundry work as steel castings are limited largely or entirely to bearing blocks, save for incidental small castings of minor concern from a structural standpoint. Except for the bearing blocks, the base portions of the housings are built up from steel plates that are welded to each other and to the cast steel bearing blocks. Such drives have proved both economical to manufacture and entirely satisfactory in service. Naturally they weigh much less than if more cast components were used.

In the latest of the steps toward all welded construction, applied today on drives of small or large capacity, there is no pattern or foundry work because the whole housing is built up in a welding shop from steel plate and slab stock. The latter is employed chiefly for bearing blocks that are flame cut quite close to size, and then are arc welded to housing components that, in turn, are welded to each other to form the housing.

Structures of this type have ample strength and rigidity for the service involved, yet weight is moderate and much below that attainable in cast housings. It is an advantage, of course, to have housings that are clean and tight and provide ideal oil reservoirs free from any sand, such as may adhere to castings even when well cleaned. Steel plates do not have porous spots, such as sometimes give trouble in castings, and if any pinholes in welds should occur, repairs are very quickly and easily made.

Although United has its own foundries whose products have unques-

Figure 2 — This housing for a drive of 800-hp embodies a cast steel lower portion and a cover made from plates arc welded together, the latter constituting a first step toward welded construction.



Case History No. 106

Rolling Mill Screwdown

9/10 LESS Lubricant Used

THE I.P. LUBRICANT

with "indestructible pH-ilm" capable of withstanding pressures up to 50,000 psi.

With BROOKS

LEADOLENE

On each eight hour shift in a large eastern steel plant 30 gallons of good quality steam cylinder oil were used on each of the two screws of a modern slabbing mill. Then LEADOLENE was thoroughly tested, and the tabulated results showed that only 3 gallons per eight hour shift were used on each screw . . . a savings of 9/10 on lubricant consumption. In addition, operating temperature of the screws was reduced from 210° F to 140° F.

On rolling mill screwdowns, the most difficult of all screws to lubricate, LEADOLENE consistently has reduced lubrication consumption and extended equipment service life. With its "Indestructible pH-ilm," plus high adhesiveness, exceptional temperature characteristics, and low pour point and viscosity, LEADOLENE gives superior service on all types of screws used to move apparatus . . . whether open or enclosed, horizontal, vertical, inclined, high or low speed.

Write for technical data or generous samples for your testing.

With LEADOLENE You Get These Characteristics Essential to Good Screwdown Lubrication

pH-ilm Strength . . . 50,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion and reduces dripping and creeping.

Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

The Brooks Oil Co.

Since 1876

Executive Offices and Plant . . . . CLEVELAND, OHIO
Executive Sales Offices . . . . PITTSBURGH, PA.
Canadian Offices and Plant . . . HAMILTON, ONTARIO
Cuban Office . . . . SANTIAGO de CUBA

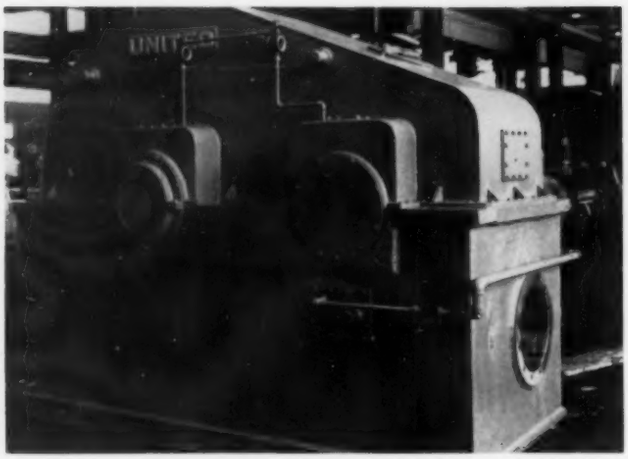


Figure 4 — Gear drive for a sheet piler that represents another step toward fabrication from steel plates. Only the bearing blocks are steel castings, but they are welded to the frame.

Figure 5 — Single and double-reduction gear drives in which the only large cast steel components of the housing are the bearing blocks welded to side plates. The cover too is a weldment but of lighter gage plate.

tioned utility, company engineers have not failed to recognize that combinations of steel castings and weldments present undoubted advantages. In some cases, even the complete elimination of castings in favor of all steel plate construction has resulted in gear drives of reduced over-all cost, and increased structural soundness justifying this welded practice from every economic and engineering point of view.

SILICONE POSSIBILITIES DEMONSTRATED IN DISPLAY

▲ New engineering materials beget inventions. That has been demonstrated many times in the case of the silicones, because these semi-inorganic materials have a unique combination of properties. These properties are, in fact, extraordinary enough to strain the credulity of many good engineers. For this reason, Dow Corning Corp., designed and built an exhibit to demonstrate those properties and to show how they are employed in many industrial and military applications. This exhibit is now traveling throughout the country and engineers in various centers are being invited to see the displays.

The exhibit gives many answers to that common question, "What's a silicone?" The display shows that silicones are fluids and resins that keep clothes and shoes and brick walls dry in the rain. They are compounds that keep radar from going blind on a foggy night. They are fluids that polish without rubbing. They also include rubbers that will not melt on hot aircraft engine cylinders or freeze on switches that operate bomb bay doors at 100 degrees below zero.

Of particular interest to the steel industry are the electrical insulating resins that double the power of electric motors or multiply by ten the life of electric motors and apparatus. Silicones are also mold lubricants that eliminate 90 per cent of the scrap in the rubber industry, and save 80 per cent of the cost of cleaning molds. They are paints that protect metal at 1000 F.

Other applications include life preservers, conservers of copper, protectors of metals, foam killers. The first section demonstrates the heat stability characteristic of silicone products. For example, water is boiled in a glass flask by nichrome wire imbedded in a sheet of silicone rubber called silastic. Parallel to this demonstration is the use of heating elements imbedded in silastic as deicing flaps on the air intake doors of jet aircraft pods.

Heat stability and resistance to hot oil is demonstrated by a device that constantly flexes a silastic bellows into an oil bath at 350 F. Gaskets and O-rings made of this same material have many applications such as seals for aircraft engines, automobile transmissions and diesel-electric locomotives.

The heat stability of protective coatings made with silicone resins is demonstrated in test samples aged at 1000 F. Heat stability of silicone electrical insulating materials is demonstrated in a motor which reverses every few seconds inducing operating temperatures of 525 F, a temperature which would cause motors with ordinary insulation to fail in a few hours. Heat stability of silicone greases is demonstrated in a pair of bearings set in blocks held at a temperature of 300 F. This plus evidence of oxidation resistance indicates that permanent lubrication is now a practical reality.

The next part of the exhibit demonstrates the usefulness of silicone products at low temperatures. The relatively low brittle points of silastic compared to organic rubbers is demonstrated by exposing both types of rubber to dry ice temperatures. Low temperature flexibility is shown by flexing a silastic bellows in a cold bath at minus 80-100 F. The relative indifference of silicone fluids to low temperatures is demonstrated by immersing in a dry ice bath a petroleum oil and a silicone fluid having the same room temperature viscosity.

Further along, demonstrations prove the fact that the same silicone products are serviceable at both high and low temperatures. For instance, bearings lubricated with ANG-25 type organic grease and a low temperature silicone grease are alternately exposed to sub-zero and oven temperatures. A continuous belt of silastic is constantly operated through a hot oil bath at 350 F and through a cold bath held at minus 80 F. Applications requiring such performance

CUT OUTAGE TIME ALL ALONG THE LINE

with OKOLITE-OKOPRENE electrical cables

Steel mill conditions are rough on electrical cables. Heat, flame, moisture, dirt, mechanical damage, corrosive fumes—the life of an electrical cable is a continual fight against such elements. Electrical men in the steel industry reduce outages due to such conditions with Okolite-Okoprene cables.

Okolite-Okoprene is particularly suitable for use in steel mills because of the exceptional properties of its electrical insulation and protective sheath.

Okolite insulation, itself resistant to heat and moisture, is highly reliable under the continuous heavy usage characteristic of steel mills. Okolite has proved itself by a long record of trouble-free operation under severe service conditions.

Okoprene protective sheath is compounded from an exclusive Okonite formulation, the basis of which is neoprene. It contains no rubber. When exposed to most acids, alkalies, chemicals, oils and moisture, it will outperform any other common type of cable covering such as lead or braid.

Okonite's famous strip process, for applying insulation and sheath simultaneously, adds still greater endurance to the cable. Conductors are perfectly centered, and both sheath and insulation are uniformly vulcanized to give higher mechanical and electrical properties of lasting quality.

Bulletin IS-1053 gives convincing facts on the stability and performance of Okolite-Okoprene. Write for it today to The Okonite Company, Passaic, N. J.

The best cable is your best policy

OKONITE OKONITE SINCE 1878 *insulated wires and cables*

9804

Figure 1 — Silicones find some of their most valuable applications in electrical equipment.

include seals for air-cooled ordnance and tank engines.

Stability of silicone fluids at both high and low temperatures is demonstrated in their use as a damping medium for automobile, aircraft and ordnance dashboard instruments, and in torsional vibration dampers for automobile and diesel engine crankshafts.

Durability of silicone products is illustrated by test samples and applications that demonstrate their exceptional resistance to oxidation, outdoor weathering and the mere passage of time.

The durability of a silicone water repellent treatment for textiles is demonstrated in a machine which alternately washes, rinses, dries and spray-rates samples of treated fabric. Another demonstration in this section on water repellency shows how above-grade concrete and masonry walls can be made non-wetting by another silicone product which does not change the color, texture or porosity of the masonry. Water repellency is further demonstrated in the buoyancy given to glass fibers used in Navy life jackets.

Many electronic applications for a waterproof silicone dielectric paste are also included in this section. This is the silicone product that was used during the second World War to keep the ignition systems of all high altitude bombers and carrier-based planes operable in spite of moisture and corona discharge.

The next section of the exhibit demonstrates the usefulness of various silicone products as dielectric materials in electric motors for industrial, aircraft and Naval installations; in transformers for military and industrial use; in generators and electronic devices including sub-miniature parts and printed circuits, transformers, amplifiers and condensers.

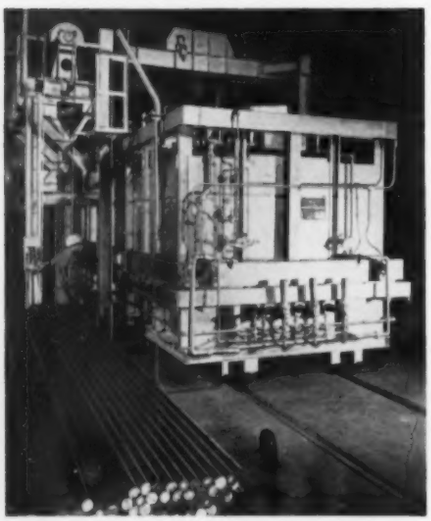
Here good dielectric properties that remain relatively constant at temperatures ranging from —70 to +500 F have proved to be most useful. Exhibits show that substantial savings in the size and weight of electrical equipment have been accomplished through the use of silicone electrical insulating materials.

Private showings of this exhibit are scheduled in such industrial centers as New York, Boston, Pittsburgh, Washington, D. C., Dayton, Chicago, and Los Angeles, Fort Worth, Houston and Wichita.

J & L INSTALLS ATMOSPHERE FURNACE

▲ A new controlled atmosphere furnace at the Hazelwood Cold Finishing Department of Jones & Laughlin Steel Corp., Pittsburgh, is now supplying customers with carbon-restored bars, making possible the attainment of heat-treated hardness at the surface without the necessity of removing a decarburized skin.

Cover of controlled atmosphere furnace is lowered over car.



The big furnace, of the car-bottom type, has been in operation since December 1, 1951. Installed by Surface Combustion Corp., of Toledo, Ohio, it is the first furnace of its kind to be designed specifically for carbon restoration. It will also perform other thermal treatments—annealing, bright annealing, spheroidizing and normalizing.

As steel passes through the various shaping processes, carbon is depleted from the skin of the bar, leaving it decarburized. The fabricator who wants a bar with enough surface hardness to resist wear and abrasion would have to machine or grind such a decarburized bar, prior to heat treating, to remove the soft, unhardenable skin.

But with the new process this surface metal removal is not required, as sufficient carbon is restored to the surface to insure that the desired surface hardness will be obtained in heat treating.

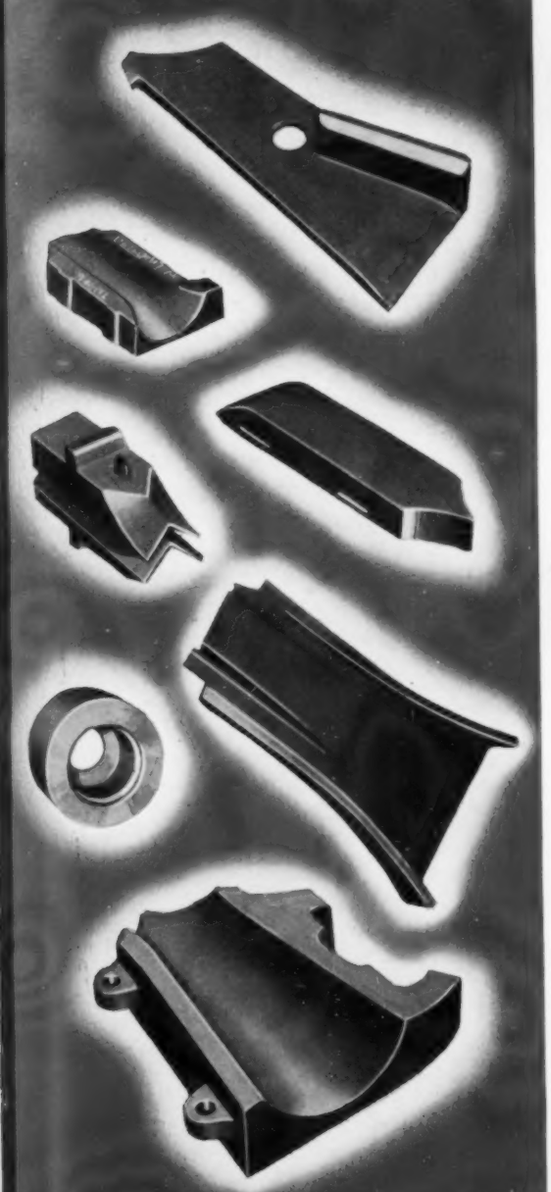
The furnace can hold up to 80,000 pounds of bars depending on their size.

The first gas, "NX", is an inert mixture of nitrogen, carbon monoxide and hydrogen, which inhibits any reaction on the surface of the bars while the furnace is being brought up to working temperature.

When the working temperature is reached, the second gas, "RX", is forced into the furnace. It also consists of nitrogen, carbon monoxide, and hydrogen, but it is richer in carbon monoxide, which provides the necessary high carbon potential for carbon restoration.

trantinyl

guides the steel industry



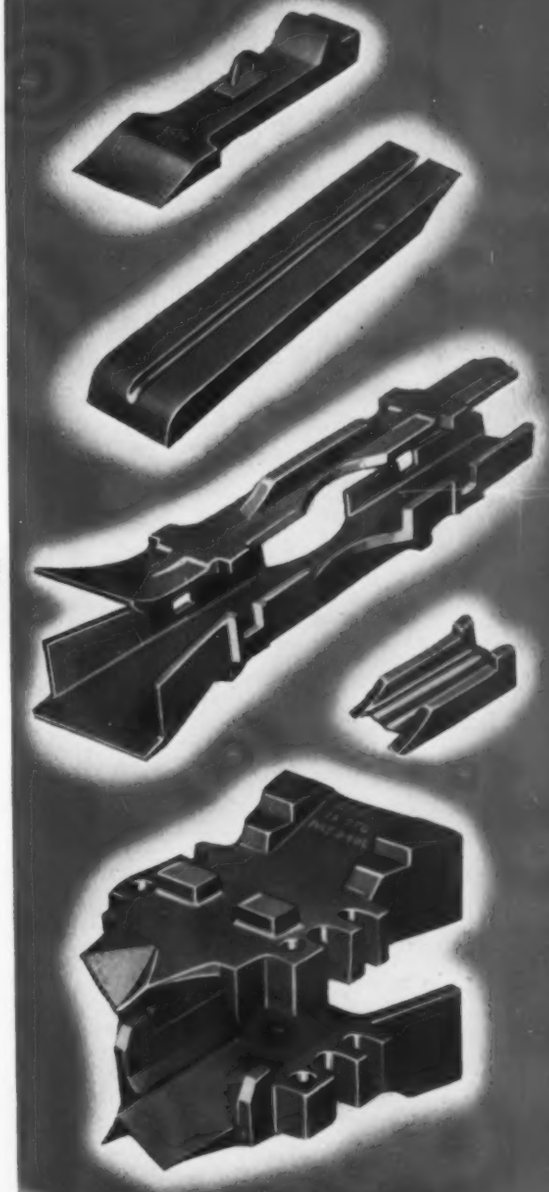
ROLLING MILLS:
bar, hoop, strip, shape
mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling
mill plugs and rolls,
piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing
rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS



YOUNGSTOWN ALLOY CASTING CORP. • YOUNGSTOWN, OHIO

CLARK MASTER SWITCHES

for every type of
MILL AND CRANE SERVICE

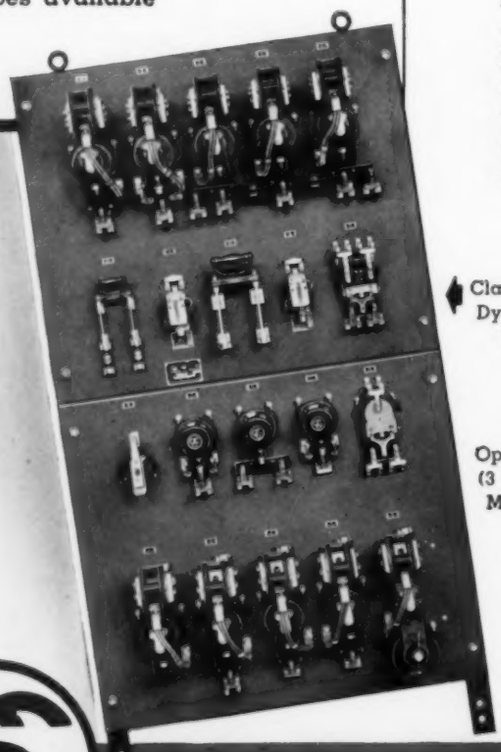
Bulletin 101, Type RD
Mill Master Switch

- Weatherproof enclosure is standard
- Dust-tight and water-tight enclosures available
- Sizes — 3 cams, 6 circuits
  6 cams, 12 circuits
  9 cams, 18 circuits
- Spring return available through a maximum of 14 circuits
- Mechanical latch at "off" point available
- Electrical interlock handle switches, and pedestal-mounted types available

CLARK Bulletin 101-RD Master Switches have been delivering maximum service in all types of heavy-duty, rough-and-tumble mill and crane applications for 14 years.

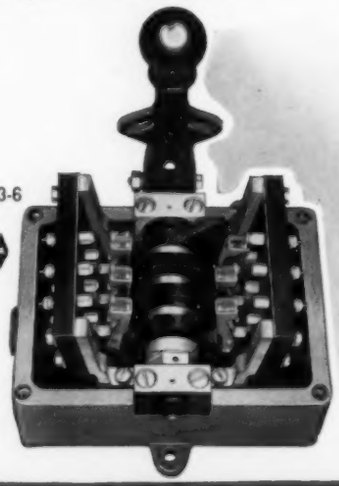
Maintenance is kept to a minimum by mounting the main shaft needle roller bearings in brass blocks. Contact finger bearings are oil-impregnated and the cam roller is made of hardened drill rod. Double-break contacts are alloy silver, requiring no dressing. High-impact Bakelite operating cams with square holes, are mounted on the square shaft, and a large nut locks steel spacers and cams to maintain their lateral positions.

Consult our nearest District Office for complete information.



Clark Bulletin 9135
Dynamic Lowering
DC Crane Hoist
Controller

Open View, Type RD-3-6
(3 points — 6 circuits)
Mill Master Switch



THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

STOP RUST! with RUST-OLEUM®

The Practical Coating!
Beautifies As It Protects!
In All Colors, Aluminum and White!

Cut maintenance costs. Apply RUST-OLEUM directly over rusted surfaces without removing all the rust! Just wirebrush and use sharp scrapers to remove rust scale and loose particles, then apply by brush, dip, or spray. Costly sandblasting and chemical precleaning are not usually required. Specify RUST-OLEUM for every rustable metal surface. Prompt delivery from Industrial Distributors in principal cities.

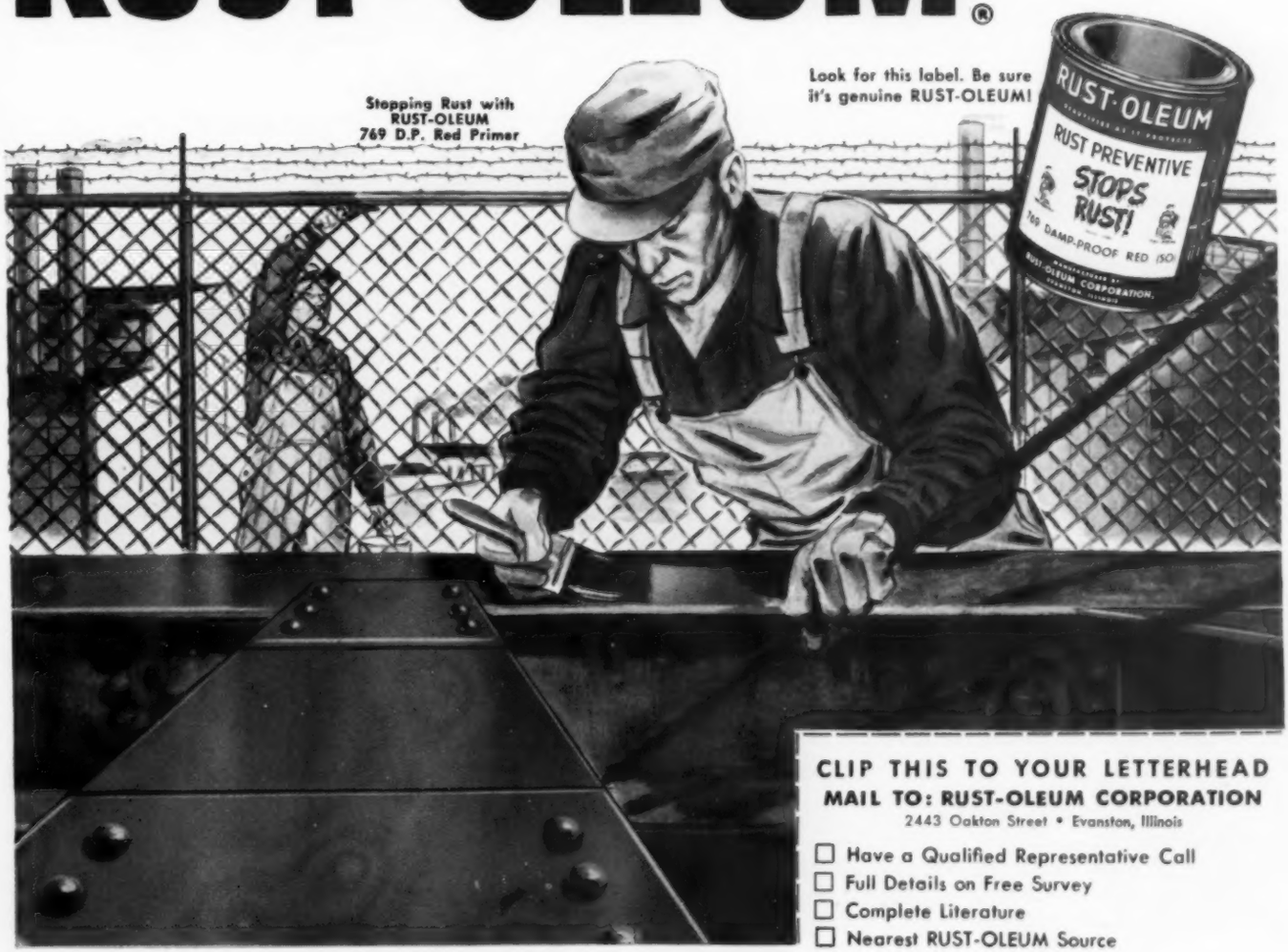
RUST-OLEUM CORPORATION
2443 Oakton Street, Evanston, Illinois

FREE SURVEY: A RUST-OLEUM specialist will gladly survey your rust problems. He'll make specific tests and recommendations. No cost or obligation. See Sweets for complete catalog and nearest RUST-OLEUM distributor, or write for literature on your company letterhead.

Protects Tanks, Girders Fences, Stacks, Metal Sash, Roofs, Buildings, Marine and Railroad Facilities

Stopping Rust with RUST-OLEUM 769 D.P. Red Primer

Look for this label. Be sure it's genuine RUST-OLEUM!



CLIP THIS TO YOUR LETTERHEAD
MAIL TO: RUST-OLEUM CORPORATION
2443 Oakton Street • Evanston, Illinois

- ☐ Have a Qualified Representative Call
- ☐ Full Details on Free Survey
- ☐ Complete Literature
- ☐ Nearest RUST-OLEUM Source

Trabon HELPS SET WORLD'S 24-HOUR TONNAGE RECORD!

At United States Steel's Homestead Works, a slab mill built by United Engineering and Foundry Company has rolled 11,153 net ingot tons in 24 hours, top record for this type of mill.

This mill, the first slab mill to use anti-friction bearings on the roll necks, is lubricated by Trabon oil and grease systems. Lubrication costs are extremely low in comparison to similar mills.

You can cover the sealed Trabon system with scale, ice, steam, water and snow without interfering with its operation.

Trabon centralized lubricating systems are widely used on plate mills, slabbing, hot and cold strip mills, blast furnaces, overhead traveling cranes, and other heavy equipment. One indicator at the pump, Trabon systems lubricate every connected bearing with the right amount of lubricant—while the machine is in operation under full load.

Let Trabon engineers help you with your lubrication problems. World-wide service.

TRABON ENGINEERING CORPORATION
1814 EAST 40TH STREET • CLEVELAND 3, OHIO

"Trabon has the only completely enclosed measuring valve that notifies the operator if trouble develops!"

Trabon
OIL AND GREASE SYSTEMS

Date-line Diary...

February 1

▲ Youngstown Sheet and Tube Co. reports net sales and other revenues for 1951 of $489,305,162 or 20 per cent over 1950. Net income totaled $30,644,201 or 25 per cent under 1950.

February 2

▲ CIO steelworkers demanded a guaranteed minimum annual wage for American industry.

February 4

▲ Based on reports of companies having 93 per cent of the capacity of the industry, the operating rate is scheduled at 100.6 per cent of capacity for the week beginning February 4. This is equivalent to 2,090,000 tons compared with 2,079,000 tons one week ago.

February 5

▲ Sharon Steel Corp. announced record net sales in 1951 of $168,958,183. Net income totaled $8,861,187 compared with $9,284,643 in 1950.
▲ Benjamin F. Fairless said that steel wages and steel prices will probably have to go up to attain industrial peace.
▲ NPA removed inventory controls on general purpose synthetic rubber.
▲ Republic Steel Corp. reported total sales and operating revenues of $1,060,371,877 for 1951. Republic thus enters the billion dollar company class. Net earnings per share in 1951 totaled $9.03 compared with $10.53 in 1950.

February 6

▲ Dr. Jules Backman testified before the Wage Stabilization Board that steelworkers were not entitled to a pay hike on the grounds of increased productivity nor is such a boost warranted.

February 7

▲ National Steel Corp. reported net earnings for 1951 of $45,287,093 or $6.15 per share compared with $7.85 per share in 1950.
▲ Central Iron and Steel Corp., Harrisburg, Pa. has asked the DPA for a loan of $55,950,000 to finance an integrated steel plant in the Harrisburg area.
▲ Japan expects to produce 5,000,000 tons of steel in 1952, and 4,300,000 tons of pig iron. Japan is now exporting steel to Europe.
▲ The Nicaro Nickel Plant in Cuba is now back in operation and should produce about 30,000,000 lb of nickel a year.
▲ The American Railway Car Institute reports that new domestic freight car deliveries in January totaled 8642. Orders in January totaled 5338 leaving a backlog on February 1 of 120,251.
▲ Acme Steel Co. declared their 291st consecutive dividend since 1901 with a dividend of 50¢ a share. Sales for 1951 totaled $81,800,000 or 18.5 per cent over 1950. Net income after taxes totaled $3.29 per share compared with $3.45 in 1950.

February 9

▲ Ohio Manganese, Inc. of Youngstown, Ohio was granted a certificate of necessity authorizing them to amortize 80 per cent of the cost of a new manganese extraction plant. Plant will use open hearth slag.

February 11

▲ The automobile industry was told it will get an extra million pounds of aluminum for automobile manufacture in the second quarter.
▲ Department of Commerce reported personal income in 1951 totaled $251,000,000,000, which is up 12 per cent from 1950.
▲ The AISI reports that the operating rate for the steel industry for the week beginning February 11 is scheduled at 100.1 per cent of capacity. This is equivalent to 2,079,000 tons compared with 2,090,000 tons one week ago.

February 12

▲ Because of slackening demand for silicon steel, Allegheny Ludlum cut back operation of its electric furnaces at Brackenridge from twenty to fifteen turns per week.
▲ Reynolds Metal Co. will expand its facilities at Listerhill, Ala. at an estimated cost of $2,000,000.

February 14

▲ DPA increased metal allotments to civilian industries for the second quarter of 1952. Steel, copper and aluminum are included in the increased allotments.
▲ A fact finding board set up by Truman told the railroads that they should grant the demands of seventeen non-operating unions for a union shop.
▲ Great Britain sold the United States 30,000 tons of lead for $12,000,000 for use in the stockpile.

February 15

▲ The Aluminum Association reported that primary production during December 1951 was 144,907,819 lb. This brings the total for 1951 to 1,673,815,416 lb. This is an increase of 16.5 per cent over the previous year. Shipments of sheet and plate for 1951 totaled 1,076,226,278 lb.

February 16

▲ F. W. Dodge Corp. reports that construction contracts awarded in the 37 states east of the Rockies in January totaled $902,091,000, off 14 per cent from January 1951.

February 17

▲ The Commerce Department reported that output of goods and services in the United States totaled $328,000,000,000 compared with $283,000,000,000 in 1950. About half of the increase was due to higher physical output and the remainder was due to higher prices.

February 18

▲ The AISI reports that the operating rate of the steel industry for the week beginning February 18 is scheduled at 100.6 per cent of capacity. This is equivalent to 2,090,000 tons compared with 2,079,000 tons one week ago.

February 20

▲ Erie Mining Co. announced that it will spend $300,000,000 on a project in Minnesota which will eventually furnish 10,500,000 tons of iron ore pellets from taconite. This includes plant on the Mesabi range northeast of Aurora, Minn.

▲ Detroit Steel filed a statement with the SEC in an attempt to register $25,000,000 worth of first mortgage bonds and 600,000 shares of $25.00 par preferred stock. Money will be used to refinance existing indebtedness and also for the firm's $55,000,000 expansion program.

▲ Crucible Steel Co. reports consolidated net income for 1951 of $8,363,000 compared with $6,311,000 for 1950. Net sales totaled $202,868,000 compared with $147,705,000 in 1950.

February 21

▲ H. A. Roemer, Jr., president of Sharon Steel Corp., reports that items such as sheet and strip steel are already in plentiful supply.

February 23

▲ Steven Hardie, boss of Great Britain's nationalized Iron and Steel Corp., resigned in a dispute with the Conservative Government. Dispute was over proposed increases in the price of steel.

▲ Fabricators told the NPA that there was more than enough stock in their plants to meet all top priority orders.

▲ CIO steelworkers gave the Wage Stabilization Board twenty-nine days to arrive at a fair solution for settling the steel wage controversy. If no satisfactory solution is arrived at by that time, the union threatened to strike.

February 25

▲ Buying and selling of natural rubber was returned to private industry after a fourteen month monopoly by the government.

▲ The AISI reports that the operating rates of the steel industry for the week beginning February 25 is scheduled at 100.9 per cent of capacity. This is equivalent to 2,096,000 tons of steel ingots and castings compared with 2,090,000 tons one week ago.

February 26

▲ American Institute of Steel Construction reports that bookings of fabricated structural steel for January totaled 210,563 tons. January shipments totaled 241,275 tons. The backlog of the industry on January 31 totaled 2,416,042 tons.

February 27

▲ Armco Steel Corp. established new sales records in 1951 with a total of $534,834,687. Net income after taxes totaled $35,004,487 or $6.69 a share compared with $11.76 a share in 1950.

▲ G. M. Humphrey, president of M. A. Hanna Co., reported that they are in the process of opening four new mines in the Lake Superior District, which will produce more than 5,000,000 tons of iron ore by 1954.

▲ Utah Construction Co. is finishing up a series of tests on a large iron ore body in Peru. If tests indicate this profitable, the company will open up an iron ore mine at this location.

▲ Bethlehem Steel Corp. reports net income for 1951 of $106,531,293 after taxes. This is equivalent to $10.43 a share compared with $12.15 a share in 1950. Total income for 1951 totaled $1,799,506,346.

February 28

▲ Bethlehem Steel Co. will spend another $289,000,000 on new plants and other facilities. Rapid write-offs have been authorized on about $221,000,000 of this amount. It is expected that another million net tons of capacity will be added in the first half of 1952, and Bethlehem's capacity at the end of 1953 will be 18,400,000 tons. The company received 800,000 tons of iron ore from its El Pao mine in Venezuela during the year and this will shortly be producing at a rate of 3,000,000 tons. Bethlehem is also sinking a shaft at its new iron ore mine near Morgantown, Pa.

▲ Allegheny Ludlum Steel Corp. reported total revenues in 1951 of $229,090,224 compared with $177,961,693 in 1950. Net earnings in 1951 totaled $8,834,140 or $5.40 a share compared with $7.07 a share in 1950 on a somewhat smaller number of shares.

▲ DPA Administrator Fleischman said that steel controls can be substantially relaxed toward the end of this year.

▲ Irving S. Olds predicted that steel production may fall below 100 per cent of rated capacity in the final six months of 1952.

February 29

▲ The NPA will increase steel allotments for first quarter use an additional 10 per cent for many manufacturers.

▲ United States Government signed a contract with the Falconbridge Nickel Mines in Toronto, under which it will purchase 50,000,000 lb of nickel produced in Ontario in the next nine years. Contract also covers the purchase of 1,500,000 lb of cobalt. United States will pay 56.66¢ per lb for the nickel.

▲ Irving S. Olds reported that United States Steel Corp.'s planned program for additional production facilities in California has been delayed by conditions at home and abroad.

LEWIS

4 high reversing cold strip mills for Dependable Production

MANUFACTURERS OF
ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES

Two 7½" and 16½" x 18" 4-High Reversing Cold Strip Mills. One Stand (slow speed 285/570 f.p.m.) for roughing and One Stand (high speed 570/1140 f.p.m.) for finishing. Material rolled — medium and high carbon steel 12" wide — gauges .118" to .020". Flexibility provided in this equipment to accommodate a wide range of maximum and minimum gauges.

May we have the opportunity of studying your requirements and submitting our recommendations.

LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Company
Pittsburgh, Pa.

personal contact . . .

a sure way to see and sell Important Buyers in the Steel Industry

There is no better way of selling the important buyers of the giant steel mill market than through *Personal Contact.* The big 1952 Iron and Steel Exposition provides the opportunity this year to see and sell—in person—the men of this fast moving industry—at a time when they are eager to learn of new and improved ideas, products, supplies or services.

For booth space . . . get in touch with us at once as there are a few good locations still remaining. They are going fast, so write, 'phone or wire today.

ASSOCIATION of IRON and STEEL ENGINEERS
1010 EMPIRE BUILDING • PITTSBURGH 22, PA.

EXHIBIT AT THE

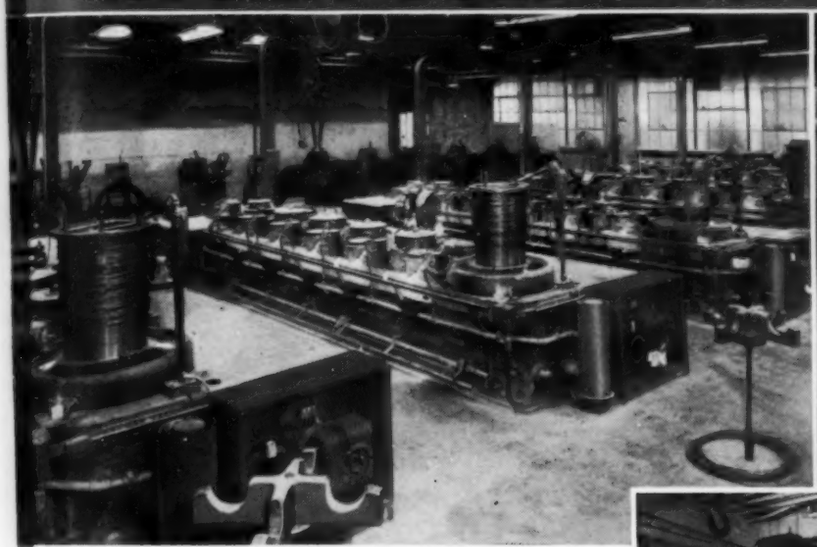
1952 IRON and STEEL EXPOSITION

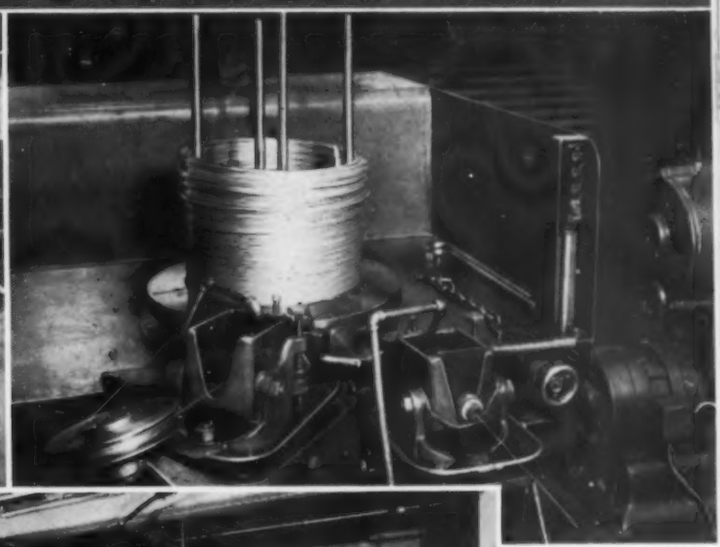
CLEVELAND
Public Auditorium

Sept. 30, Oct. 1, 2 and 3

. . . the real measure of Vaughn® Performance!

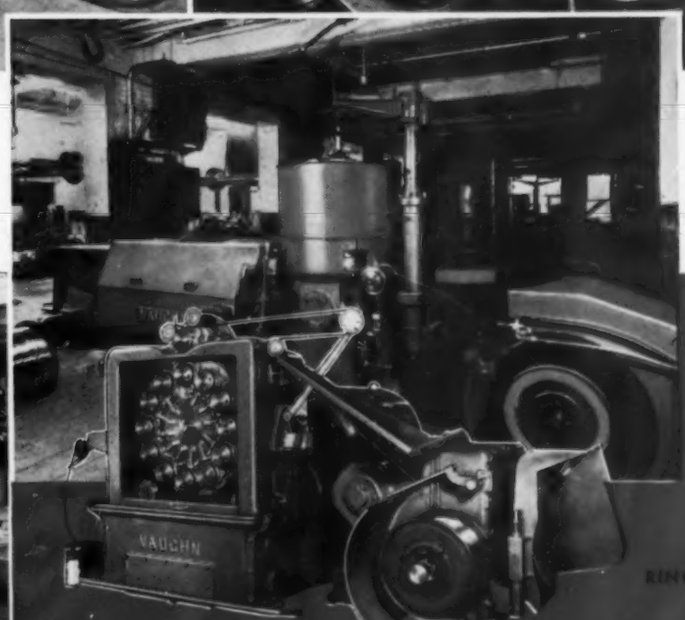
VAUGHN COLD DRAWING EQUIPMENT





MOTOBLOX ®

MOTOBLOC ®



DRAWBENCHES

CONTINUOUS MACHINES

RINGBLOX ®

How much will your contemplated new equipment *produce*—in your plant, on your schedules, to your standards—and at what cost? We welcome the yardstick of PRODUCTIVITY applied to Vaughn Cold Drawing Equipment, because *Vaughn measures up!* Let us discuss the facts, at your convenience.

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

Sea water cure for lagging steel production

A PLAGUE of steel furnace production is down-time for bottom repairs. Good medicine for excessive repairs is Permanente 165 *periclase* ramming mix—derived from sea water magnesia of highest purity.

One of the most important developments in furnace construction in the last decade, Permanente 165 has an MgO content of more than 95% after burn-in. And Permanente 165 bottoms *retain higher strength* during prolonged use.

Accurately sized, pre-shrunk periclase grains give high density. *Full depth bond* is assured because patented Permanente 165 bonds itself by means of crystal-bridging.

This high refractoriness, plus great resistance to chemical attack, means less down-time for repairs between heats, increased tonnage per year. Breakthrough danger is reduced to a minimum!

YOUR Kaiser refractory engineer will give prompt attention to your refractory problem—will offer, where desired, research, design and installation service to give you maximum production most economically. Write for descriptive literature on Permanente 165 and on the companion ramming mix, Permanente 84. Principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron, Ohio.

Kaiser Chemicals

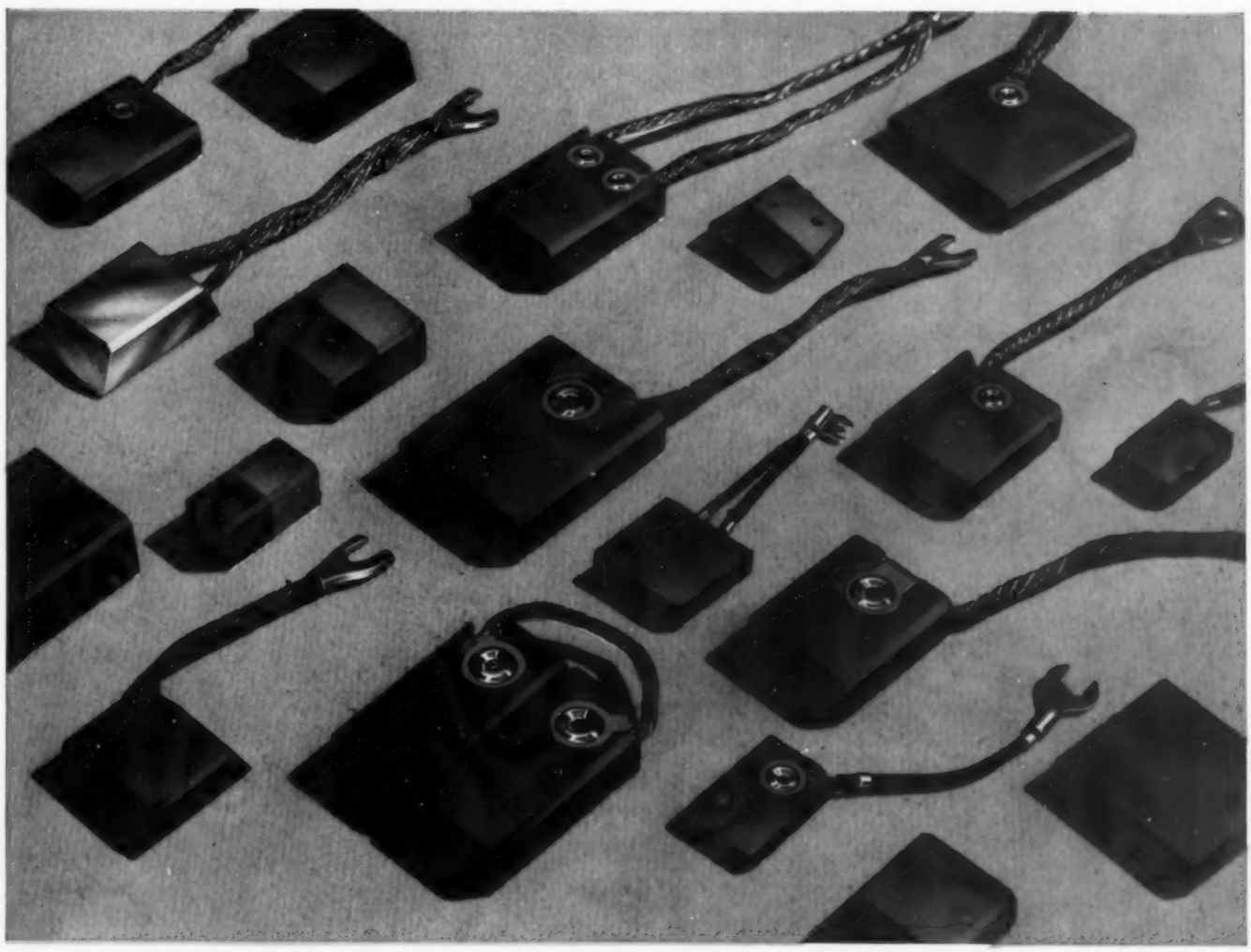
Pioneers in Modern Basic Refractories

Basic Refractory Brick and Ramming Materials • Dolomite • Magnesia • Magnesite • Alumina • Periclase

BUY USG BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

Write today for 40-page catalog giving complete information on standard USG grades.



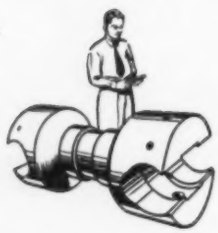
90-B

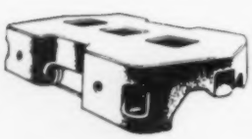
THE UNITED STATES GRAPHITE COMPANY

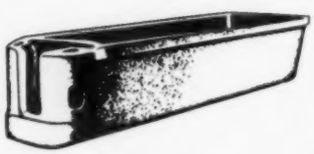
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

First things first!

The greater part of Union's output is now earmarked for military needs . . . for equipment that demands steel castings which must stand up under unusual shock, stresses, abrasion and fatigue. Orders are being filled just as rapidly as Defense requirements will permit.







UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

Industry News...

ERIE MINING CO. PLANS FACILITIES FOR PRODUCTION OF IRON ORE PELLETS

▲ A large-scale development in Minnesota for producing up to 10,500,000 tons annually of iron ore pellets from taconite is under consideration by Erie Mining Co. Erie is owned by Bethlehem Steel Corp., Youngstown Sheet and Tube Co., Interlake Iron Corp. and Pickands Mather & Co.

An application for a certificate of necessity covering the entire project on a basis of 10,500,000 tons, estimated to cost about $300,000,000 has been filed with the Defense Production Administration. Final decision to undertake the development depends upon the action taken by the Government on the company's application and the solution of certain tax problems.

The program calls for constructing a plant on the Mesabi Range northeast of Aurora, Minn., to produce the concentrated iron ore pellets from taconite, the low-grade iron formation which abounds in Minnesota. It also calls for building a new community east of Aurora for the plant employees and their families, a large power plant, and a railroad to carry the pellets from the plant to docks and loading facilities at Two Islands, Minn., on the north shore of Lake Superior.

If the project is undertaken, the initial unit would have an annual capacity of at least 5,000,000 tons, Mr. Hoyt said, which would probably take about four or five years to attain. According to present plans construction of additional units would continue until production is at the rate of 10,500,000 tons per year. This procedure would assure maximum production at the earliest possible date.

Erie Mining Co. for several years has operated a preliminary taconite plant at Aurora for experimental purposes, which last year produced and shipped about 70,000 tons. This is the only plant in existence which has produced pellets in large quantities from Lake Superior taconite.

GAS PIPE FOR FAIRLESS WORKS

This wide diameter pipe soon will be shipped to Morrisville, Pa., where U. S. Steel's new Fairless works is under construction. There it will be used to carry gas from coke ovens to other operations in the big mill. Sparks fly as hooded workman welds pipe at the Ambridge, Pa. plant of the company's American Bridge Division.

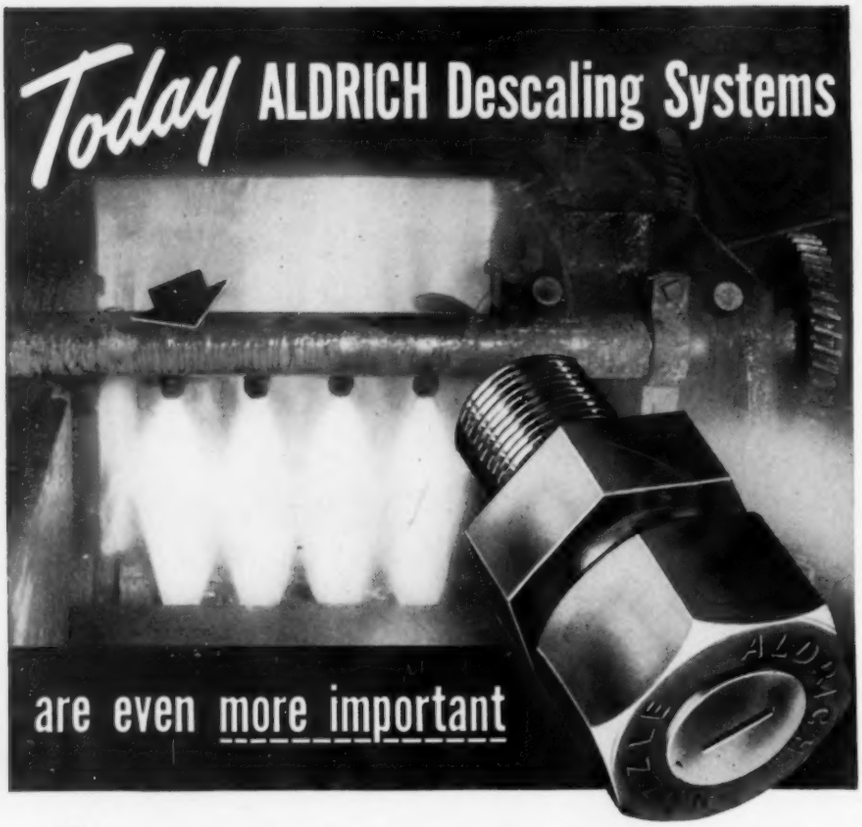
COPPER ALLOY IS USED ON BULLET JACKETS

▲ Substantial savings in the country's critical copper supplies are being made through the use of copper alloy-clad steel rather than solid "gilding metal" in the production of bullet jackets, according to E. J. Reardon, vice president of Superior Steel Corp., Carnegie, Pa. This method, which was used extensively during World War II, produces clad metal in the form of strip—the metal being basically a core of steel with relatively thin layers of copper on both sides.

Formerly, clad metal was made by "peening" gilding metal plates into a modified I-beam shape of steel. These steel sections were limited in width to about 10 in. and in weight to between 600 to 1000 lb. Since most bullet-jacket presses were designed to use strip about 5 in. wide, this method was entirely satisfactory, although not as economical as might be desired because of the relatively low yield of fully clad strip. Yield of the copper alloy, however, was quite high; the loss in shearing being practically all steel.

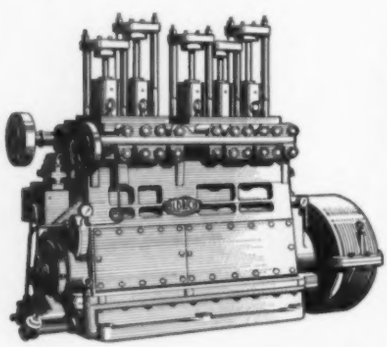
In 1948 Superior replaced two outmoded hot rolling mills (maximum strip width: 8 in. and 12 in.) with a high speed, precision 20 in. hot strip mill. Installation of this new mill and the development of a new type "welded angle" assembly removed the weight limitations on the assembled clad slab and further raised the yield of usable clad strip to a very satisfactory level—both of which resulted in lower costs.

Present clad billets, made by the "welded angle" method, weigh from 2000 to 3000 lb. Finished strip is



Because the metal industries *need* peak production. And when it comes to descaling—an *Aldrich* system is the quickest means of getting the finish required.

Aldrich Spray Nozzles employ a Venturi tube, embodied in the body and disc, to direct flow through a *rectangular* orifice. This produces a knife-edged *line* of water with an impinging force equal to 95% of the potential energy supplied to the orifice. The sharp jet and the striking force developed by Aldrich nozzles give far more effective descaling than jets of equal force but with a larger impinging area, produced by more water at lower pressure . . . Aldrich Spray Nozzles are available from stock. *Write for Data Sheet 61-2.*



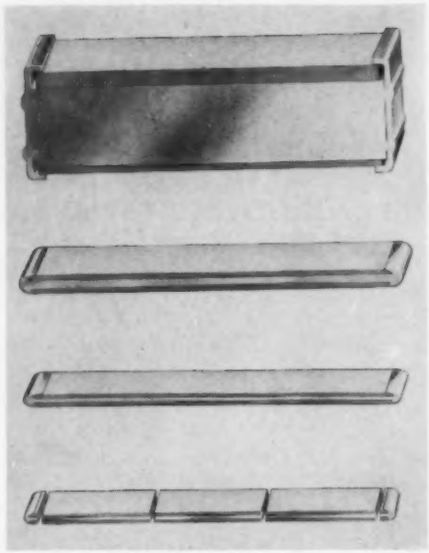
The Aldrich Pump for your system may be a Direct Flow Triplex or other Multiplex unit . . . fitted with Aldrich Patented Synchronized Suction Valve Control, or Automatic By-Pass Valve to operate with all types of accumulators. For your *complete* Descaling System, or for pumps for roll balancing or press operation: call on Aldrich! Write today for Data Sheets on equipment.

THE ALDRICH PUMP COMPANY

21 PINE STREET, ALLENTOWN, PENNSYLVANIA

. . . Originators of the Direct Flow Pump

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles • New York Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.



Top to bottom: (1) Base metal plus cladding material assembled prior to rolling. (2) Section after hot rolling. (3) Section after cold rolling. (4) Cold-rolled section after slitting.

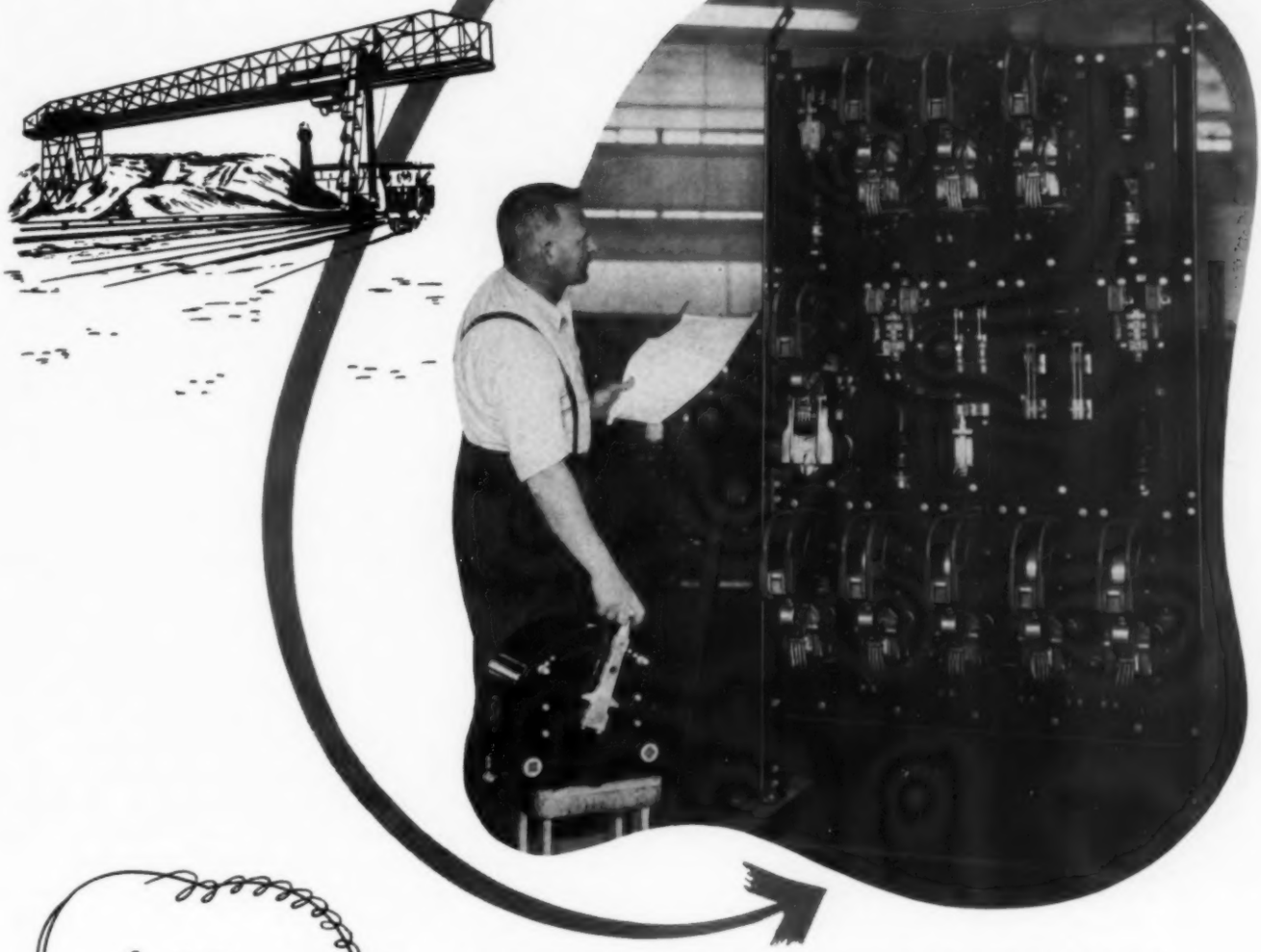
produced in widths up to 17 in. Another important feature of the improved assembly method is its flexibility. Practically any combination of cladding thickness between 5 and 30 per cent, equal or unequal on one or both sides, can be produced. It now is possible to clad different metals or alloys, if fairly compatible, to either side of a steel core—to use practically any type of steel—or even to use as the core various metals or alloys other than steel.

In essence, Superior's method of cladding today involves the fastening together of plates of cladding metals and plates or slabs of steel. The assembly is heated and hot rolled into strip, pickled, cold-rolled, normalized or annealed, re-pickled and slit to desired widths. The finished strip consists of specified thicknesses of cladding metal, inseparably bonded to one or both sides of the core and in condition suitable for blanking, drawing or whatever further processing is required to produce a finished part.

It is a matter of record that arsenals in this country and in certain foreign countries accept this clad metal as the equivalent of, and in most cases superior to, solid gilding metal or solid cupro-nickel, for the manufacture of bullet jackets. Scrap produced, both in manufacture of strip and ammunition components, is further processed to separate the steel and the copper-alloy so there is no loss of steel or copper.

A multi-million dollar expansion

Helps Speed Ore Movement



In 1912, fifty steel mill men came to Cleveland to witness the first dynamic lowering hoist control—when EC&M demonstrated that loads could be safely handled and the expensive-to-maintain mechanical load brake could be eliminated.

THIS TYPICAL EC&M CONTROLLER (and a duplicate) will soon be placed in service to control the hoisting, lowering, opening and closing of a two-motor bucket hoist on an ore bridge.

For this and similar crane-hoist applications, EC&M Control Apparatus and Control Engineering have earned a reputation for quick, easy manipulation of material handling equipment. Less tiring to the operators, this EC&M equipment enables them to maintain high output *continuously*. And maintenance men know that magnetic controllers using EC&M LINE-ARC Contactors are unequalled for low maintenance.

EC&M Crane Controllers are fast—and safe, too.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

AMERICAN CHEMICAL PAINT COMPANY
AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: IMPROVED DRAWING AND COLD FORMING WITH GRANODRAW

INTRODUCTION:

When steel is phosphate coated with "Granodraw" prior to working it, drawing, extrusion, and other cold forming operations are greatly improved. In fact, the protective phosphate coating makes the cold extrusion of steel possible.

Getting cold steel to flow depends on the unique properties of this coating. Its non-metallic phosphate crystals are physically and chemically adapted to acquire a strongly adsorbed lubricant. The combination of adherent phosphate coating and adsorbed lubricating film possesses a low coefficient of friction while maintaining its integrity under extremely high deforming pressures.

The drawing of wire and many other cold forming operations — including the cold extrusion of steel — are greatly facilitated by the application of a "Granodraw" phosphate coating and a suitable lubricant prior to working.

"GRANODRAW" DATA

"Granodraw" zinc phosphate coating chemical is applied to pickled surfaces in an immersion or spray process. When used with a suitable lubricant, the coating reduces friction under conditions of low, medium, or high deforming forces encountered in such typical operations as: cold extrusion of steel; cold shaping; deep drawing (tubs, cartridge cases, shells, etc.); stamping; drawing of wire and tubing; ironing; necking; nosing; and upsetting.

ADVANTAGES OF PHOSPHATE COATING WITH "GRANODRAW" PRIOR TO COLD FORMING STEEL

The following are among the advantages indicated for phosphate coating with "Granodraw" prior to cold forming steel:

Drawing of wire, bars, tubing, etc. — Improved lubrication; improved surface; less scratching; reduced pull; greater percent reduction per pass; reduced die wear; longer die life; lower die maintenance and cost; reduction in corrosion.

Drawing of stampings, shells, shell cases, etc. — Improved lubrication; reduced breakage; reduction in scrap; deeper draws; less scratching; elimination of some annealing; less wear on dies.

Cold Extrusion — Improved lubrication; increased strength of parts; improved surface; reduction in load on press; greater dimensional accuracy; more uniform wall thickness; longer extrusions; elimination of some annealing; less corrosion.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "GRANODRAW" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

program is now in progress at the Superior plant in Carnegie to assure a greater supply of clad metal. A joint effort by U. S. Army Ordnance and Superior Steel, the expansion will result in the production of an additional 4000 tons per month of clad metal. Superior is furnishing the land, buildings and utilities. The U. S. Government is supplying $5,250,000 worth of equipment and facilities which include: two new annealing and pickling lines; a new coiler for Superior's hot mill; and a new clad metal billet assembly line. Also, from existing stand-by facilities, the Government is furnishing three 30 in., 4-high cold mills; one 20 in., 2-high cold mill; shears, levelers and other equipment. In addition, the government is supplying two additional bullet cup annealing and pickling lines to augment Superior's original line, and has furnished a number of bullet-cup presses to Superior's sub-contractor.

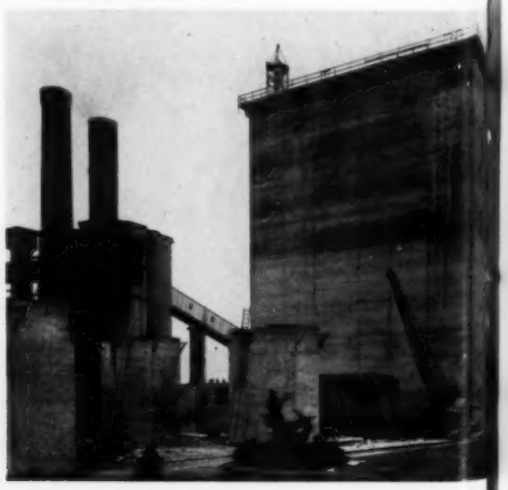
BASIC REFRACTORIES EXPANDS IN OHIO

▲ The dimensional magnitude of Basic Refractories $3,500,000 expansion program at Maple Grove, Ohio, necessitated by the tremendous increase in steel demands, is reflected by the new stone storage silo. The stone, quarried and processed at Maple Grove, is almost chemically pure dolomite and is classed a metallurgical ore.

Standing 122 ft high, the silo is believed to be the tallest of its kind in the world.

Housing 12 bins, the silo will store

The world's tallest stone storage silo has been built by Basic Refractories. Concrete piers shown in the foreground will hold two new rotary kilns.



LOW COST PRODUCTION WITH

Wide Strip Annealing Furnaces

Increased tonnage with production economy . . . that's the actual experience reported by a leading steel company, operating Drever continuous annealing lines for 42-inch coiled silicon steel strip, pictured above.

Users report consistent, uniform anneal and excellent surface characteristics; resulting in increased stamping die life.

Cleaning is incorporated in the line, thus eliminating a separate operation.

Both quality and low cost production are designed, engineered and built into Drever Wide Strip Annealing Furnaces.

Complete annealing lines for Low Carbon, Tin Plate and Galvanizing stock; also Non-Ferrous strip. Capacities up to, or even exceeding 60,000 lbs. per hour.

View of two 20,000 lb. per hour DREVER CONTINUOUS ANNEALING LINES for 42" wide STEEL STRIP. Delivery end, showing 1820 K. W. Vertical Strip Furnaces and strip recoiling equipment.

P.S. Our many years of experience is available to you, without obligation, in discussing your particular requirements.

DREVER CO.

730 E. VENANGO ST., PHILA. 34, PENNA.

CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT

W. PENNA.: N. Y. AND OHIO H. C. BOSTWICK, 19405 S. MORELAND BLVD., CLEVELAND, 22, OHIO

TM *Alloy Steel*

CHAINS

DO MORE WORK, LAST LONGER,

COST LESS . . . THAN WROUGHT IRON TYPES

This Registration Ring bears the chain's serial number and safe working load. It's your assurance of thorough testing and inspection.

Your chain problems are substantially reduced when you buy TM Alloy Steel Chain. Records prove this famous chain *outlasts* and *outperforms* wrought iron types . . . even under the toughest conditions. It's more economical too!

TM Alloy Steel Chain has twice the tensile strength. Controlled heat-treatment assures a uniform hardness of from 265 to 285 Brinell. These features make it highly resistant to abrasion, cold-working, grain growth and shock at all temperatures.

Send for free booklet containing all the facts and specifications on TM Alloy Steel Chain and attachments.

S. G. TAYLOR CHAIN COMPANY
Dept. 5, Hammond, Indiana
Rush literature and prices on TM Alloy Steel Chains.

NAME _____

ADDRESS _____

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

approximately 10,250 tons of No. 6 stone (⅜-in.) in eight of the bins and, in addition, a substantial tonnage of supplemental raw material in the other four. This stone tonnage alone is sufficient to fill 145 ordinary gondola cars for a train length in excess of 1¼ miles.

An interesting sidelight and one that may reach economic import is the fact that Basic's No. 8 stone (passes a 0.075 in. screen and meets state specifications for concrete sand) is being used to prepare the concrete for this modern plant.

The new silo will be fed by a cross belt from the adjacent silo, which in turn is fed by a 735-ft conveyor from the stone mill at the quarry site.

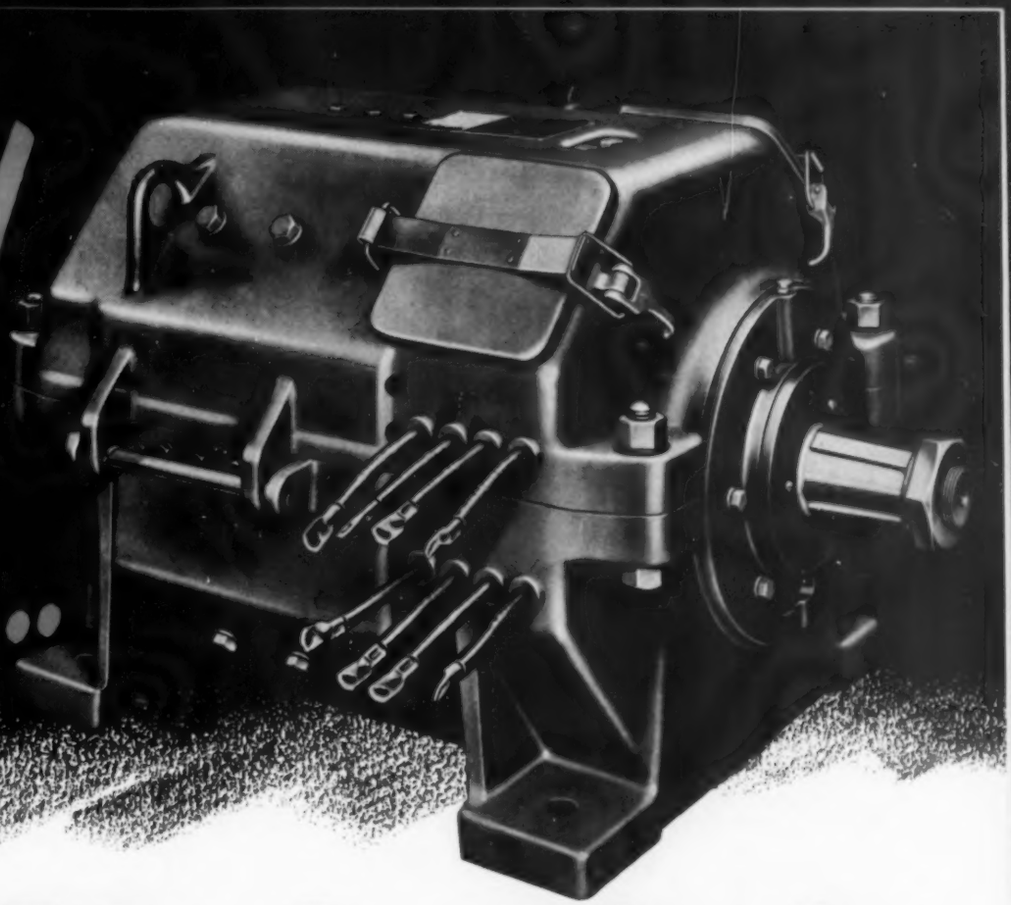
The expansion program is expected to be completed before mid-year. Remaining on the agenda are: the construction of two, 215-ft steel stacks (at the silo end of the piers) to handle kiln gases; the mounting and assembly of two new rotary kilns; and the construction of the finished product and coal handling sections.

Incidentally, the new kilns when assembled will measure 390 ft in length and will be the largest in the refractory industry.

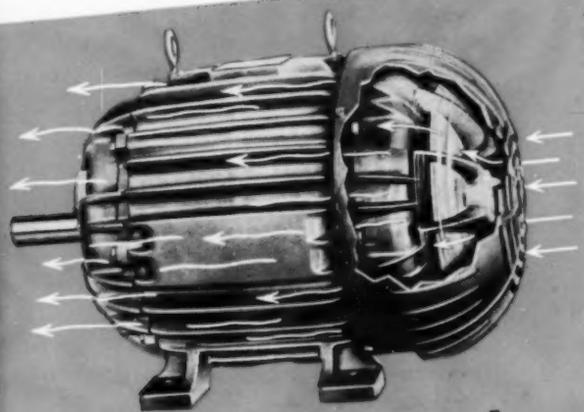
FLOATING SULPHUR MINE

From this 200-ft steel barge, shown being launched near New Orleans, La., Freeport Sulphur Co. will mine defense-essential sulphur in the Louisiana marshland at Bay Ste. Elaine, the first marine project in the industry's history. The portable plant will supply nearly 2,000,000 gallons of superheated water a day to melt the sulphur deep underground. Next summer, it will be towed 65 miles from Grande Ecaille, where mining equipment is now being installed, to Bay Ste. Elaine and partly submerged in a prepared slip.

As rugged as it looks...



ELLIOTT Crocker-Wheeler
600 SERIES MILL MOTOR



Another Tough One!
ELLIOTT CROCKER-WHEELER SEALEDPOWER MOTOR

A totally-enclosed, fan-cooled induction motor that cools and cleans itself by a constant stream of fan-driven air directed along the outside of the finned case. Reliability proved by ten years of successful applications under most trying conditions. In 3 to 125 hp. Also available in vertical type, and in explosion-proof underwriter's approved. Ask for the Sealedpower Bulletin.

■ Here's a motor than can take the worst that's handed out in heavy duty mill and crane service, and come up smiling. Due to advanced engineering, it packs as much as 1/3 more power in each standard size frame. Rugged cast steel split frame allows quick access to armature, bearings, field coils. From 5 to 265 hp. Also available *separately forced ventilated, protected self-ventilated, back geared.* Write for the Mill Motor Bulletin.

ELLIOTT Company

CROCKER-WHEELER DIVISION
AMPERE, N. J.

Plants at: JEANNETTE, PA. ● RIDGWAY, PA. ● AMPERE, N. J.
SPRINGFIELD, O. ● NEWARK, N. J.

BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES
ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY

CW-40

the streamlined answer to steel handling problems...

ROSS STRADDLE CARRIERS + UNIT LOADS

Old concepts of steel handling are fast giving way to this modern method. Why? Because unit loads provide flexibility that cannot be equalled by car-load-lot handling . . . flexibility made possible by wide-ranging ROSS STRADDLE CARRIERS. Self-loading and unloading, these machines require only an operator . . . no locomotive and switching crews . . . no riggers . . . no expensive, space-consuming trackage . . . no endless shuttling of cars. And ROSS Straddle Carriers for steel mills are built like battle ships to give dependable service in tough steel mill operating conditions. Want proof? Just ask mills which have converted to ROSS STRADDLE CARRIERS what *they* think!

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors throughout the World

400 MILLER STREET, BENTON HARBOR, MICHIGAN, U. S. A.

INTERNATIONAL GRAPHITE CONSTRUCTS NEW PLANT

▲ Ground has recently been broken to start the construction of new graphitizing facilities which will greatly increase the production of graphite electrodes at the Niagara Falls, N. Y., plant of International Graphite and Electrode Corp., a subsidiary of

Speer Carbon Co., St. Marys, Pa. Covering 25 acres, the expansion is being undertaken by IGE to meet the increasing demand of the electric steel and chemical industries.

Costing $10,000,000, the new facilities will include a calciner, 16 graphitizing furnaces, and complete milling, extruding and baking facilities. It is expected to be in full production by May, 1953. Each unit is being constructed in such a way as to start producing immediately when it is finished.

AETNA-STANDARD ADDS RUBBER DIVISION

▲ E. E. Swartswelter, president of The Aetna-Standard Engineering Co., Pittsburgh, Pa., announces the purchase of the rubber and plastics machinery division of the National-Erie Corp., Erie, Pa., wholly owned subsidiary of Bucyrus-Erie Co.

The purchase includes the drawings, patterns and special equipment required in the manufacture of this machinery. Aetna-Standard will manufacture the rubber and plastics machinery products in their Warren, Ohio, plant. Sales, design engineering and development work will be handled by their associate, Hale & Kullgren, Inc., Akron, Ohio.

Aetna-Standard has long been a

You can pick out

THE MAIN REASON WHY THIS FARREL® DRIVE IS SO EFFICIENT

The high efficiency and quiet operation of a Farrel combination mill drive and pinion stand are due to a large extent to precision generation of gears and pinions by the famous Farrel-Sykes process. This method of generation assures extreme accuracy of tooth spacing, contour and helix angle, which pays off in smooth, uniform power flow.

To keep power-transmission efficiency "young" through long years of service, the drive is equipped with a unit-type pressure lubricating system with separate motor-driven pump. This provides a continuous spray of oil at the mesh line of all gears and pinions and force-feed lubrication to all antifriction bearings.

Designed to suit individual requirements, Farrel rolling mill drives and pinion stands — separate or combination units — are available in any capacity. Farrel engineers will be glad to supply full information for any specific application.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

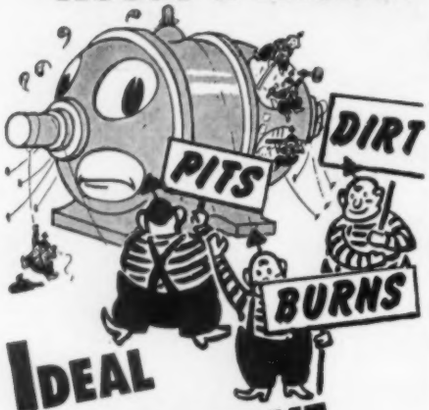
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Los Angeles, Houston

— FARREL ROLLING MILL MACHINERY —

Rolls • Rolling Mills • Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Gears • Mill Pinions • Pinion Stands • Gear Drives of Any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Lead Presses for Pipe or Rod.

FB-688

When a Motor Needs a Friend!



IDEAL PREVENTIVE MAINTENANCE

restores commutators and slip rings at low cost without dismantling . . . keeps motors running like new . . . saves overhauls and shutdowns

RESURFACERS
Refinish commutators and rings to like-new condition even when ridged, scored or burned.

MICA UNDERCUTTERS
Stop sparking—help commutation—prolong brush life. For all sizes of commutators.

PRECISION GRINDERS
For more than surface smoothing — under machine's own power. Accurate to .001"

FLEXIBLE ABRASIVE
Cleans and burnishes commutators. Non-dusting. Complete size range.

FREE 40-page Handbook
All you need to know about commutator and slip ring maintenance. Mail coupon.

IDEAL Products are sold through Leading Distributors

IDEAL INDUSTRIES, Inc. (IDEAL)
1045 Park Avenue, Sycamore, Illinois
send FREE HANDBOOK and information on
☐ Resurfacers ☐ Undercutters
☐ Precision Grinders ☐ Flexible Abrasive
NAME_____
COMPANY_____
TITLE_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

foremost producer of equipment for steel, copper, brass and aluminum. They are best known for continuous butt weld pipe mills, seamless tube mills, continuous galvinizing and tinning lines, flat-rolled equipment and drawbenches. Mr. Swartswelter emphasizes that they will continue primarily as a manufacturer of these products. In fact, the company recently expanded their Ellwood City, Pa., plant for this purpose. The rubber and plastics line will supplement Aetna-Standard's existing lines of machinery.

ATLANTIC STEEL CO. BUILDS NEW WAREHOUSE

▲ Atlantic Steel Co. will construct a new half-million dollar warehouse and office building at the corner of Northside Drive and 14th Street in Atlanta, Ga., for its warehouse division, it was announced by Robert S. Lynch, president of the company.

The primary reason for constructing the new building at the present time, according to Mr. Lynch, is that existing warehousing facilities of the division will be needed to accommodate the increased production to result from Atlantic Steel Co.'s new electric furnace which is expected to be in operation soon.

The location is considered ideal as it is only a short distance from the new West By-Pass and is adjacent to U. S. Highway 41 and the Southern RR.

The structure will have 67,200 sq ft of warehouse and facilities space and 6700 sq ft of air-conditioned office space. It will be located on a nine-acre tract now being graded. The building will be 45 ft high.

The new location and facilities of the warehouse division will provide the company's customers with better service and a larger variety of steel warehouse products.

The structure is so designed that three railway cars at a time may be loaded or unloaded in the building's interior. Dock loading facilities will accommodate seven large trucks.

In addition to warehousing steel products for distribution throughout seven Southeastern states, the division will offer shearing, flame-cutting, sketch plate burning and hack saw cutting equipment facilities to metal fabricators and users.

Atlantic Steel Co. established its warehouse division in 1947. It is operated separately from the steel mill itself and buys products from Atlantic Steel in much the same manner as other customers of the company.

The division sells large quantities of steel and copper products not manufactured by Atlantic Steel. Currently about five per cent of the total tonnage produced by Atlantic Steel is sold through its warehouse division.

AUTOMATIC NAMES NEW CLEVELAND

▲ The newly established firm of Robert M. Slife and Associates, Inc. was named Cleveland, Ohio, area sales and service representative for the Automatic Transportation Co.

Mr. Slife, who will serve all of northeastern Ohio, has made his headquarters at 3744 Prospect Avenue, Cleveland.

CONSULTANTS OPEN ENLARGED OFFICES

▲ Ramseyer & Miller, Inc., consulting engineers for the iron and steel industry, announce the opening of new and enlarged offices at 11 West 42nd Street, New York 18, N. Y.

REFRACTORY EXPERTS

Dr. Eduard Bargezi, managing director of the Austro-American Magnesite Works, Radenthein, Austria, largest refractories manufacturing operation in Europe, points out an interesting phase of the Austrian works to Dr. Russell P. Heuer, vice president, General Refractories Co. Dr. Bargezi, who is on a business tour of the United States, will soon return to Austria. The Austro-American Magnesite Works is a subsidiary of General Refractories Co., Philadelphia, Pa.

COKE FIRM INCREASES ORE BRIDGE CAPACITY

▲ To increase the handling capacity of its five-ton ore bridge, the Pittsburgh Coke and Chemical Co., Pittsburgh, Pa., in conjunction with the construction of "B" furnace, has awarded Dravo Corp. a contract to fabricate and install a new lightweight man trolley.

Because the trolley design incorporates modern equipment and materials that make it lighter in weight, the existing bridge, built originally by Dravo in 1929, will now be able to handle 8½-ton ore loads instead of five-ton.

OAKITE PRODUCTS MOVES NEW YORK HEADQUARTERS

▲ Oakite Products, Inc., manufacturers of specialized cleaning and allied materials, have announced the transfer of the company's general offices from 22 Thames Street to newer and larger quarters at 19 Rector Street, New York 6, N. Y.

Factors contributing to the move, which represents still another step in Oakite's continuing expansion program, have been the increased use of Oakite cleaning and related materials by industry and the steadily growing demand for technical advisory service and special research. Acquisition of the new office space will permit a substantial increase in the facilities of the Oakite chemical research and engineering laboratories, and is designed to assist the company in providing augmented technical advisory service to industry in connection with problems encountered in today's stepped-up civilian and defense production.

PRATT & WHITNEY MOVES PITTSBURGH OFFICE

▲ In order to expand its service to its customers in Pittsburgh, Pa., Pratt & Whitney of West Hartford, Conn., has relocated its Pittsburgh office in a new, modern building at 683 Lincoln Ave., Pittsburgh 2, Pa. New telephone number is ROsewood 1-7212.

Additional space provided at the new location permits Pratt & Whitney to carry a more comprehensive stock of regularly listed P&W precision cutting tools and gages, and gives adequate office area for the factory-trained sales and service personnel associated with the large line of machine tools, cutting tools and gages produced by Pratt & Whitney and its subsidiary, Potter & Johnston Co. of Pawtucket, R. I.

The office is under the management of W. W. Stoner, Jr., district manager. The staff includes E. J. Stokes, machinery sales engineer; J. C. Williams, cutting tool and gage sales engineer; J. R. Cooper, gage sales engineer; and J. E. Hecht, office sales, cutting tools and gages.

RELIANCE MOVES IN DETROIT AND CLEVELAND

▲ District sales offices of the Reliance Electric & Engineering Co. in both Detroit, Mich., and Cleveland, Ohio, have been moved to larger quarters. The Detroit office, at 3105 East Grand Blvd. for the past 15 years, is now located at 12326 Hamilton Ave. Telephone number is Townsend 8-5510.

Reliance's Cleveland district sales office, which has been located at 1200 Ivanhoe Road since 1948, is now operating from 13967 Cedar Road. Telephone number is FAirmount 1-7880.

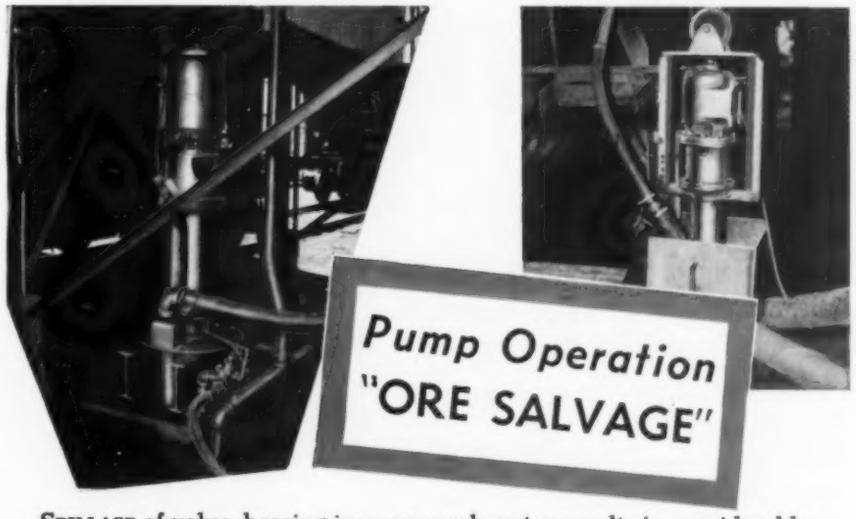
CARBIDE TOOL GROUP TO AID SHELL MAKERS

▲ The American Ordnance Association now has in full operation a carbide cutting tool sub-committee of its Shell Committee. Representing all manufacturers of tungsten carbide cutting tools, the committee serves as advisors on carbide problems arising in shell manufacturing.

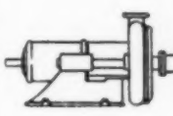
All available technical data on application of carbides in shell manufacture has been assembled and a list is available to shell producers. Shell producers are being advised of additional bulletins as rapidly as they are prepared by individual carbide producers.

Assistance is also being provided to shell producers by the carbide committee on the organizing of training programs relating to the application of carbides in shell production.

Chairman of the Committee is J. S. Gillespie, Carboloy Department, General Electric Co. Membership includes P. E. Floyd, Allegheny Ludlum Steel



SPILLAGE of value-bearing iron ore wash water results in considerable loss in car loading operations like these, on the Missabi Iron Range. It also causes messy conditions for the operators. Nagle type "SW-OB" pumps with no stuffing box and no submerged bearings recircuit these waters from spillage collecting sumps to further processing and keep the area dry and clean. The job is dirty, gritty, abrasive — no job for any but the toughest pumps. Job-tailored abrasion resistant water-end parts and maintenance that is a marvel of simplicity are just two of the many reasons why more gruelling pumping jobs are handled by Nagles. Write for the Nagle solution to your most abrasive or corrosive application, whether it calls for vertical or horizontal pumps.



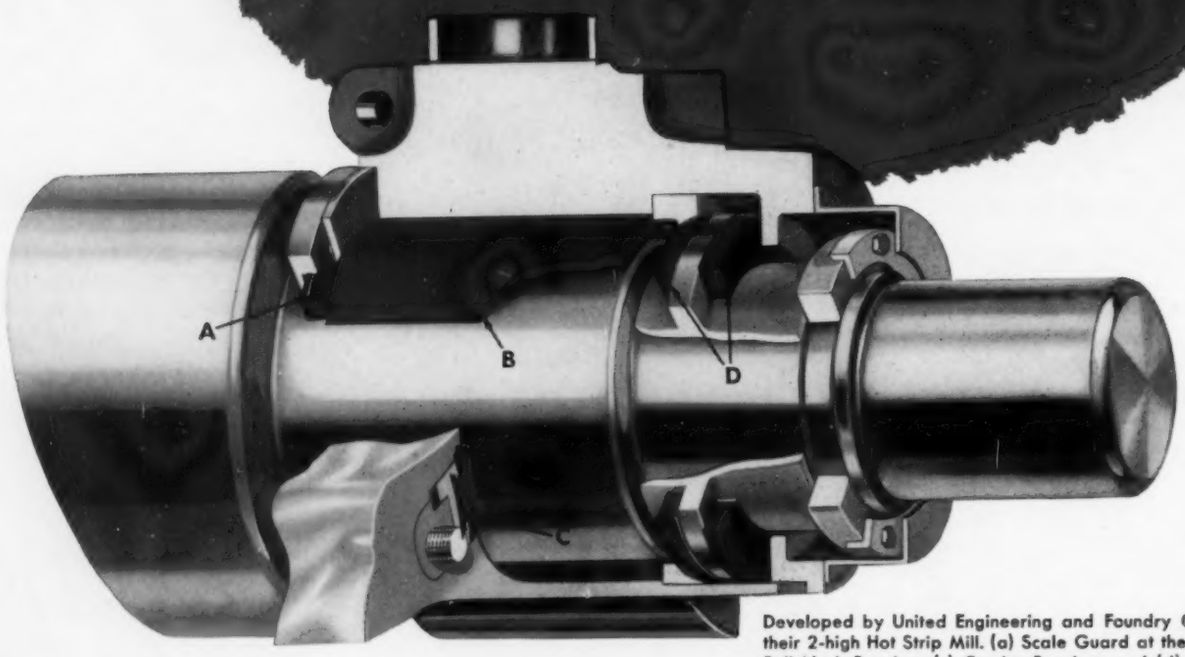
Nagle Pumps INC.

INDUSTRIAL PUMPS FOR ABUSIVE APPLICATION

1263 CENTER AVENUE, CHICAGO HEIGHTS, ILLINOIS

NEW...

Enclosed roll neck assembly with A-B-K bearings for more efficient mill operation

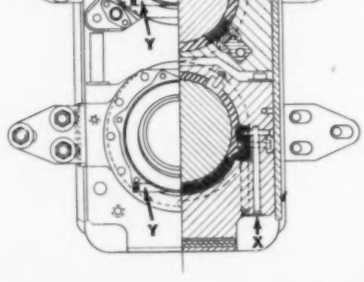


Developed by United Engineering and Foundry Company for their 2-high Hot Strip Mill. (a) Scale Guard at the roll fillet; (b) Roll Neck Bearing; (c) Carrier Bearings and (d) Thrust Rings.

Fully enclosed, and made from A-B-K laminated plastic. Scale can't reach the bearing surfaces. Lubrication by water is ample and fully controlled; yet oil or grease can be easily added to prevent rust during mill shutdown.

Thus to A-B-K material's advantages of longer bearing life, exceptional resistance to shock and low coefficient of friction is added complete bearing protection, at all times.

Investigate A-B-K Roll Neck Bearings, Thrust Collars and Slipper Bearings. They save power, permit better holding of gauge, sharply reduce down time and maintenance costs. Various formulas are available. Write for our new folder, American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Michigan.



The position of the bearings on the roll neck and provisions for lubrication. "X" is the inlet port, "Y" the outlet.

Copyright 1952, The American Brake Shoe Co.

AMERICAN Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

Corp.; M. E. Backstrom, Firth Sterling Steel & Carbide Corp.; Bennett Burgoon, Kennametal, Inc.; R. T. Beeghly, Metal Carbides Corp.; H. W. Highriter, Vascoloy-Ramet Corp.; and W. N. Howley, Chairman, AOA Shell Committee.

Information as to available carbide tooling data or training programs should be addressed to J. S. Gillespie, Chairman, Carbide Cutting Tool Sub-Committee, American Ordnance Association Shell Committee, c/o Carboloy Department of General Electric Co., Box 237, Detroit 32, Mich.

FCC RULE CHANGE EFFECTS MANY PLANTS

▲ NEMA wishes to call to the attention of all users of induction and dielectric heating equipment, particularly those whose equipment was manufactured prior to June 15, 1947, the provisions of the FCC Rules and Regulations, Part 18, relating to radiation and communication interference from industrial induction and dielectric heating equipment.

In essence the rules require certification, on or before June 30, 1952, of compliance with certain minimum radiation requirements for all equipment installed or manufactured prior to July 1, 1947. A period of five years was allowed by the Commission for users of uncertified equipment to properly check and obtain certification of their equipment. The deadline date of June 30, 1952, is rapidly approaching and all such users of uncertified equipments should take due notice and take steps to comply with the Commission's rules.

It is suggested that users of older type equipments contact the manufacturer of the equipment or a consulting engineer for guidance in complying with the rules. A complete copy of the FCC Part 18, Rules and Regulations Relating to Industrial, Scientific and Medical Service, may be obtained from the United States Government Printing Office, Washington, D. C.

ONE BILLION DOLLARS TO BE SPENT IN 1952

▲ The steel companies of the United States, engaged in the largest steel expansion program ever undertaken, spent a total of $1,041,000,000 for new equipment and construction during 1951, American Iron and Steel Institute reported today. That was a record high outlay, 103 per cent above the $513,000,000 spent during 1950.

In 1952 the companies plan to spend even more money—about $1.3 billion according to the Institute, on the basis of estimates supplied by the companies. If that is accomplished, the outlay during the seven years 1946 to 1952, inclusive, will be over $4.7 billion, an amount equal to 70 per cent of the industry's estimated total investment at the start of last year.

Last year the companies increased their combined annual steelmaking capacity more than 4.3 million tons to a record high level closely approaching 108.6 million tons.

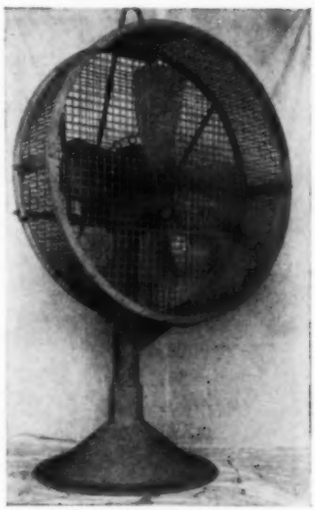
In 1953 another large outlay will be required to bring annual steel capacity to the expected record high level of more than 120,000,000 tons. In 1946, just after the end of the war, capacity was 91.9 million tons. In addition to steel furnaces current capital expenditures provide other necessary iron and steel facilities, such as blast furnaces, coke ovens and rolling mills.

USE THE ENGINEERING MART

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

Koppers Rebuilds Blast Furnace...

Increases Iron-Producing Capacity

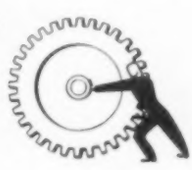
● This new blast furnace was recently constructed by our Freyn Engineering Department. It has a hearth diameter of 25 feet and a capacity of 1,100 net tons of iron per day. The old furnace, which it replaced, had a hearth diameter of 21 feet and a capacity of 776 net tons of iron per day.

Soaring 225 feet skyward, this new blast furnace will, of course, produce far more iron each year than the old one. In fact, it is estimated that the annual increase in production will amount to 112,000 tons.

Besides enlarging the hearth, Koppers engineers installed the most modern accessory equipment throughout the new furnace. All that remains of the old stoves, for example, are the shells and a portion of the original foundation.

Constructing blast furnaces is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

PUT YOUR SHOULDER TO THE WHEEL
SEND IN SCRAP TO MAKE MORE STEEL!

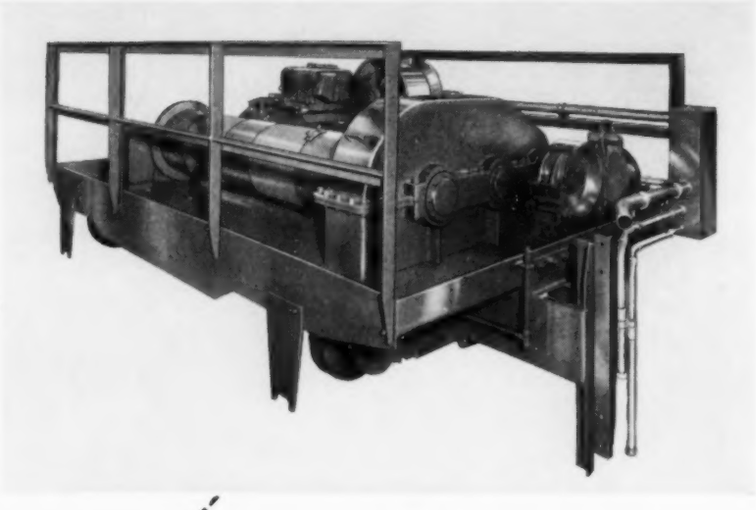


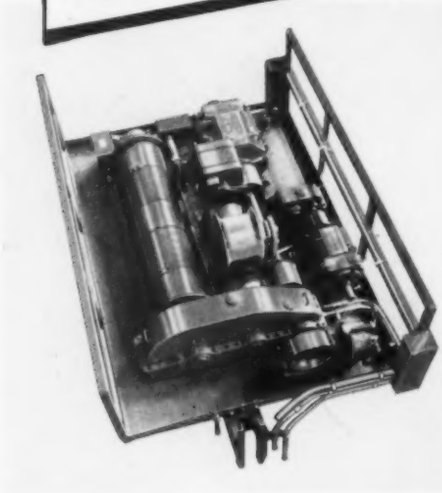
KOPPERS

Engineering and Construction Division

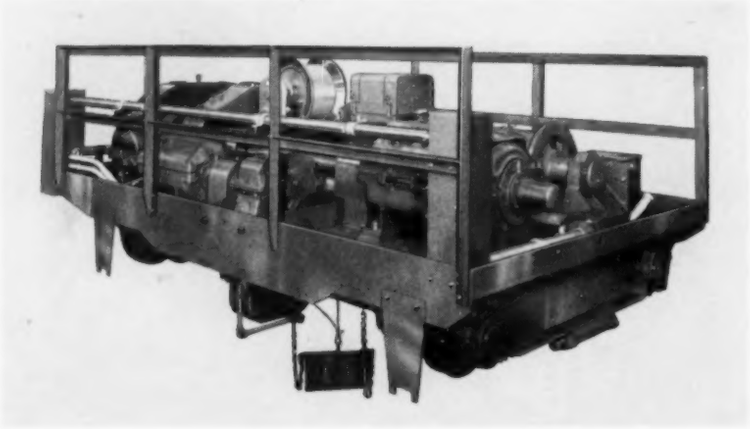
KOPPERS COMPANY, INC. • PITTSBURGH 19, PA.

"Shaw-Box"





A.I.S.E.



STEEL MILL CRANES

For Steel Mill Cranes, built to fully interpret A.I.S.E. specifications, look to "Shaw-Box". In each, fine engineering, careful workmanship, and long experience are combined to insure efficient, 'dependable, low-cost crane service with minimum maintenance under the most severe operating conditions.

Examine the clean-cut appearance and rugged construction of this "Shaw-Box" 15-ton capacity, single hook Magnet Crane Trolley, built to A.I.S.E. specifications. Notice the oil-tight gear case and pedestal bearings integral with the totally decked and toe-boarded frame, the sheave supports mounted above the frame, and the accessibility of parts for easiest maintenance. "Shaw-Box" has designs to A.I.S.E. specifications for the popular sizes and types of mill cranes, together with the different variable optional units preferred by individual mills. To meet specific applications, "Shaw-Box" Cranes to A.I.S.E. specifications are more readily available at attractive prices.

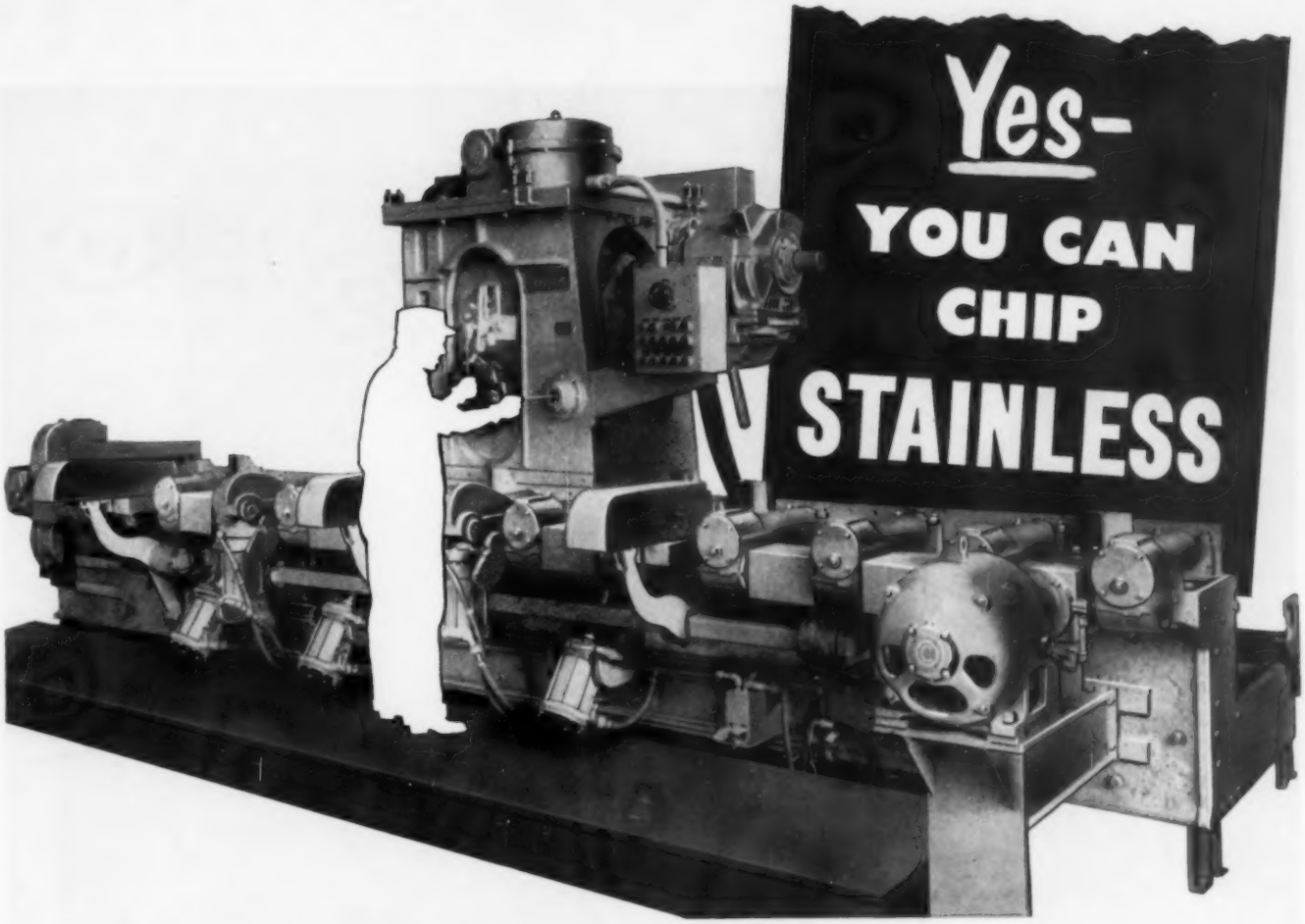
That's why you, too, will be choosing wisely in selecting "Shaw-Box" A.I.S.E. Cranes for your mill.

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to Shaw-Box".

SHAW-BOX CRANES

MANNING, MAXWELL & MOORE, INC. MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.



. . . and the Bonnot Billeteer easily handles other "Tough Babies" too!

Bonnot Billeteering is producing surprising results with stainless steel. While we are not inferring that the "highest-brinell rated" stainless is being chipped, *exceptional results are being consistently obtained in brinell classifications under 400.*

And when it comes to toughness, let's consider 52100 high chrome, high tensile steel that's always a problem to condition:

With a Bonnot Billeteer the operator completely skinned (full surface removal) *in just 8 hours,* 8 sides of 7" square blooms, 10' long plus 5 sides of 14" square, 15' long . . . *2900 square inches per hour with Bonnot Billeteering.*

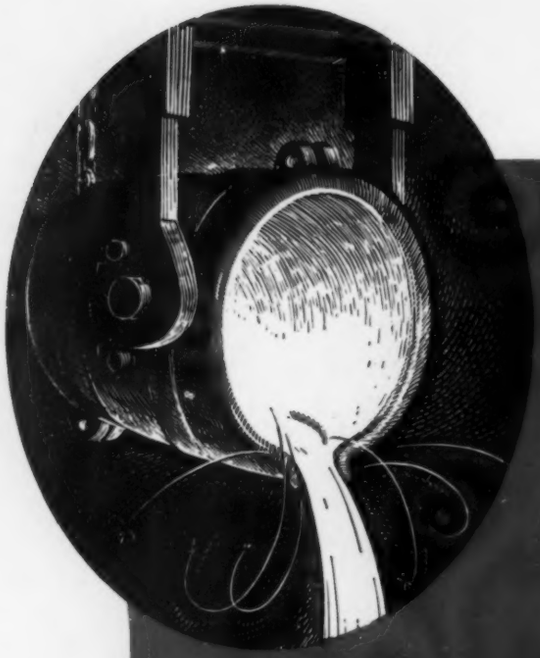
Yes, steels of the toughest varieties—with or without annealing treatment—are being successfully chipped by the Bonnot Billeteer every day, everywhere in the industry.

If you still are struggling with laborious, dangerous billet conditioning methods it will pay you to find out about Bonnot Billeteering. A real investigation of production being obtained may surprise you greatly. Never a better time to find out—and never an obligation.

Engineered For Improved Production

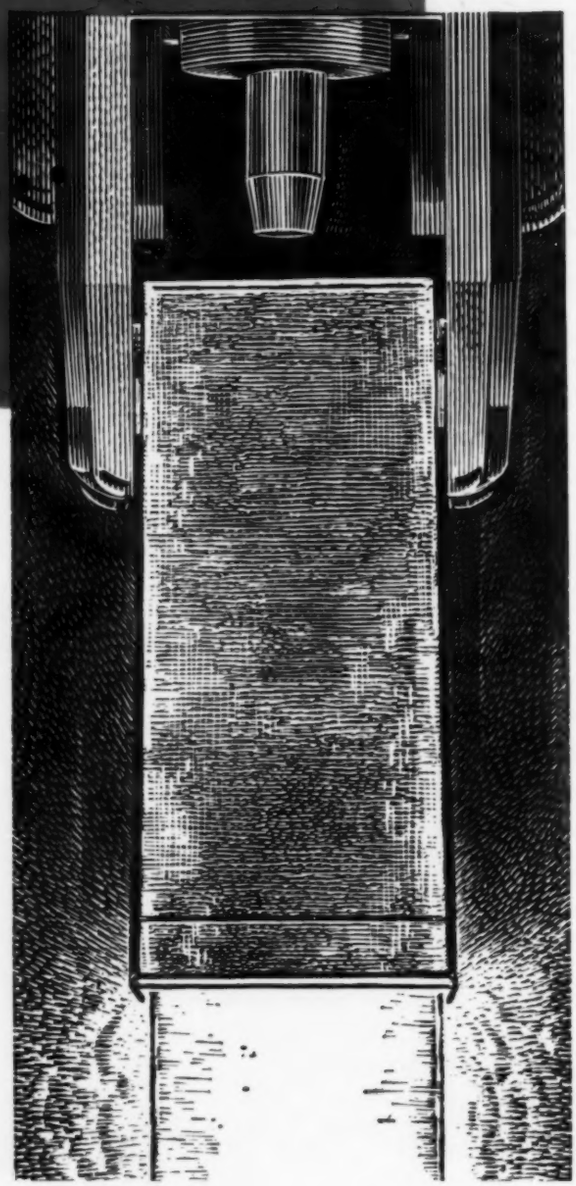
The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
CRUSHING • DUST PUG MILLS • SINTER PLANT PUG MILLS



POUR FASTER...

STRIP FASTER.



AND ADD LIFE TO CRITICAL MATERIALS with NATIONAL TRADE-MARK Graphite Stool Inserts!

Mold stools with graphite inserts stand up to the hot-metal impact of fast, uniform pouring... absolutely *eliminate* the bottleneck of stool-sticker slow-ups. Ingot cars move evenly... you get greater man-hour productivity and, incidentally, much longer life from essential materials and equipment.

Write to National Carbon Company for information.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg

Personnel News...

William B. Kennedy and **William G. McDonough** were appointed division superintendents of National works of National Tube division, U. S. Steel Co., McKeesport, Pa. Mr. Kennedy will be in charge of pipe production, finishing and shipping. Prior to this appointment he was division superintendent blast furnaces, open hearths, bessemer and rolling mills. Mr. McDonough will supervise operations in the blast furnaces, open hearth, bessemer and rolling mills. He had been superintendent, open hearth and bessemer department.

J. E. Kessler was named chief engineer—appropriation analysis and preparation, United States Steel Co., Pittsburgh, Pa. **N. C. Michels** has been appointed chief engineer—project development and **E. L. Tindall** becomes chief engineer—manufacturing. Until his new appointment, Mr. Kessler was chief engineer—engineering and raw materials. Mr. Michels was chief engineer—project development in the engineering and raw materials department. Mr. Tindall was chief engineer—manufacturing in the engineering and raw materials department.

Charles F. Benninghoff was appointed assistant superintendent, coke ovens and by-products, at Kaiser Steel Corp., Fontana, Calif. Starting with Kaiser Steel in 1943, Mr. Benninghoff came from the Colorado Fuel and Iron Corp., where he had been employed as research chemist.

Kenneth R. Casey was appointed superintendent, roll shop, at Kaiser Steel Corp., Fontana, Calif. Mr. Casey succeeds A. B. Frost, deceased.

John E. Rohrbach, for the last nine years foreman of seamless tube roll shop at Campbell, Ohio, works has been appointed assistant roll designer for the Youngstown, Ohio, district of Youngstown Sheet and Tube Co.

Donald E. Rice, formerly assistant general superintendent, U. S. Steel Co., Columbia-Geneva division, Pittsburg works, Pittsburg, Calif. has been promoted to general superintendent, Torrence works, U. S. Steel Co., Torrence, Calif.

R. P. Liggett, general superintendent of blast furnaces, Republic Steel Corp., Cleveland, Ohio, has been appointed full time secretary of that company's blast furnace committee. Mr. Liggett will be succeeded as general superintendent by **J. R. Barnes.** Mr. Barnes will be assisted by Harry Shields who was formerly at Republic's Canton, Ohio, plant.

Barney N. Dagan was named assistant general superintendent of the Fontana, Calif., plant of Kaiser Steel Corp. **Clarence R. Lohrey** becomes division superintendent of iron and steel, and **William G. Schulze** was appointed superintendent of coke ovens and by-products. In his new position, Mr. Dagan, formerly division superintendent of iron and steel, will be responsible for the operations and services divisions at the Fontana works, reporting to the general superintendent.

Earl F. Blank, special assistant to the vice president—employee and public relations, Jones & Laughlin Steel Corp., Pittsburgh, Pa., retired January 31. Mr. Blank started with J&L in 1925 as director of safety and welfare. In the ten years that he served in this capacity he established the first central safety and welfare department for the corporation. In 1935 he was named personnel relations director and was responsible for the establishment of J&L's personnel relations department. In 1947, Mr. Blank was made assistant to vice president—employee and public relations and served in that capacity until September, 1951, when he was appointed special assistant to the vice president—employee and public relations.

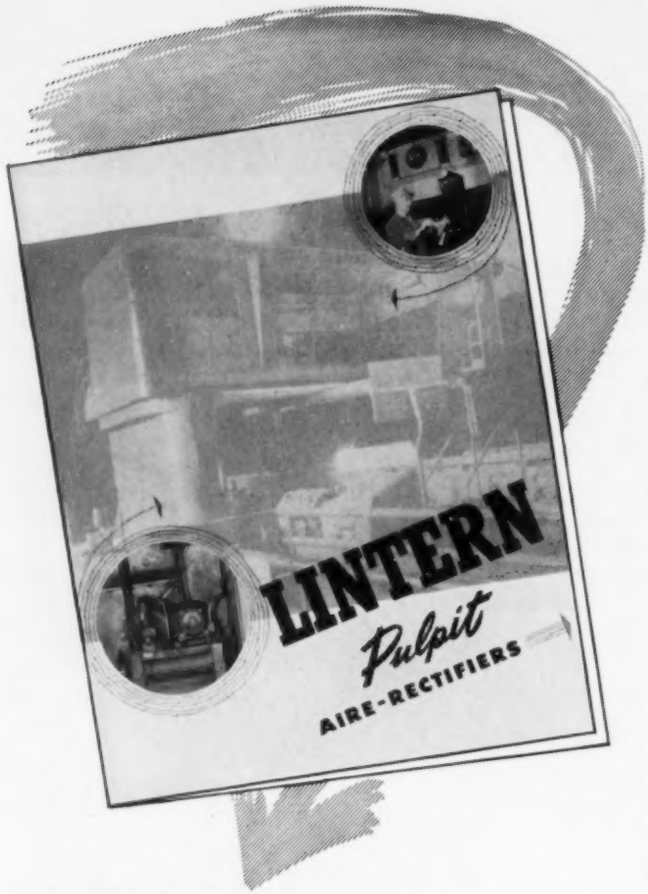
O. D. Rice, chief engineer of Rust Furnace Co., Pittsburgh, Pa., was appointed to the position of manager of operations, created to coordinate the firm's multiplied activities throughout the United States and Canada. **H. Hayward Dinneen** was appointed chief engineer to succeed Mr. Rice. Other promotions announced at the same time were those of **Leonard G. Meier** to chief draftsman, and **Richard W. Ewalt** to assistant manager of sales.

WM. B. KENNEDY

WM. G. McDONOUGH

H. HAYWARD DINNEEN

RICHARD W. EWALT



ESSENTIAL TO
Capacity Production

This new folder illustrates and describes Lintern Pulpit Aire-Rectifiers and their possible application to your requirements.

A majority of the pulpits, in the present expansion program, will be Lintern equipped. This expenditure to increase the efficiency of these skilled operators is a paying investment—essential to capacity production.

The line of Aire-Rectifiers is complete for all types of mill pulpits—for those of the most modern design to existing pulpits where costs must be kept down. Many parts are interchangeable with the crane cab Aire-Rectifiers, thereby keeping service parts stocks at a minimum. Sturdy and corrosive-resistant, especially designed and built to handle the heavy-duty, high temperature requirements of steel mill operation, these pulpit Aire-Rectifiers are not to be compared with ordinary commercial units. They have proven their merits in successful operation over the past four years. They do not require bulky, unsightly air ducts, nor valuable space within the pulpit.

Send today for folder. If you will tell us your conditions we can then write you fully.

THE LINTERN CORPORATION
29-2 RIVERSIDE DRIVE • BEREA, OHIO

Stephen A. Keller has been named general manager of the Valve Division of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. He succeeds **James H. Binger,** who will continue as vice president of the division.

Leroy Brooks, Jr., who was president of Tool Steel Gear and Pinion Co., Cincinnati, Ohio, recently became chairman of the board; **LeRoy R. Brooks,** former vice president and secretary, became president; **Sanford M. Brooks,** former vice president and treasurer, was elected to the position of executive vice president and secretary; **Harry M. Hopkins,** former works

LEROY R. BROOKS

manager, was made vice president in charge of operations; **Clarence R. Burrell,** former general sales manager, was made vice president in charge of sales; **Stan-**

CLARENCE R. BURRELL

ley Woodward, former assistant secretary, was made treasurer; **N. C. Strohmenger,** former chief metallurgical engineer was made assistant vice president in charge of metallurgy; **John J. Stolz,** former chief engineer, was made assistant vice president in charge of engineering, and **John C. Seeger,** former assistant general sales manager, was made general sales manager.

Thomas E. Lloyd has been appointed assistant to the president of Salem-Brosius, Inc., Pittsburgh, Pa. Mr. Lloyd previously had been manager of publications, American Institute of Mining & Metallurgical Engineers and editor of the Institute's publication,

7 YEARS' SERVICE

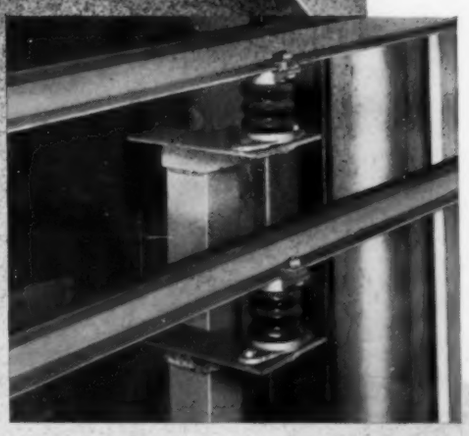
...STILL GOING STRONG AT ALAN WOOD STEEL

Keystone Collectors

Proof of the rugged, reliable service of Keystone equipment is found in the Alan Wood Steel plant at Conshohocken. Keystone Universal Collectors have been on the job for over seven years supplying positive contacts with an inverted "V" rail. Weather, dirt, grease did not impair their efficiency.

Positive contact, despite misalignment as great as 5" vertical and 8" horizontal, is assured with patented swivel base and head on Keystone Universal Collector. It is adaptable for all classes of industrial crane, conveyor and other work requiring a moving contact of medium power capacity.

Throughout Alan Wood Steel—as in other industrial plants—Keystone Collector and insulation equipment is in constant use in strip mill, coke plant, blast furnaces . . . wherever positive insulation and contacts are required. To cut maintenance . . . install Keystone. Write for latest catalog.



Keystone Contact Rail Insulator Type BHB at Alan Wood Steel. Clamps permit free movement of rail for contraction and expansion.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

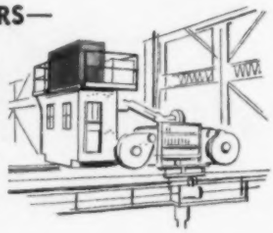
only at DRAVO can you get a COMPLETE LINE of CRANE CAB COOLERS and CONDITIONERS

No matter what radical temperature variations or atmospheric conditions occur in your industry, there's a Dravo Crane Cab Cooler or Conditioner available to protect your crane cab operator, safeguard his health, increase his efficiency and alertness, and improve safety and production records in your operations.

Dravo Crane Cab Coolers and Conditioners provide complete air conditioning, filter the air, remove dusts, dirt and fumes; heat the cab in winter, cool it in summer and provide constant ventilation the year around.

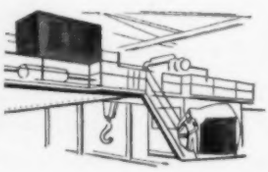
SELF-CONTAINED COOLERS—

Mounted alongside the cab or on the cab roof. Only electrical leads and connections required. Thermostat control—fully automatic—maintains 85° F. temperature with ambient temperatures up to 225° F. Ideal for "hot spots" in steel and other metal-working industries.



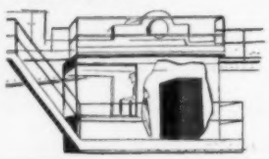
SPLIT-TYPE COOLERS—

Installed on the crane in two sections—the heavy condenser unit *on the crane* wherever you want it—the light cooling section *in the cab* with the operator. Two sections joined only with refrigerant pipe and electrical connections.



SMALL HEATERS AND VENTILATORS—

Especially designed to filter dusts and dirt, remove fumes, provide constant ventilation, supply heat in winter. Ideal for cranes in quarrying, slag, cement and similar industries.



One source of supply—Easy Installation

Dravo is your *one source of supply* for all crane cab coolers and conditioners. Units are quickly and easily installed with a minimum of downtime required. Parts are interchangeable on all units.

Available for immediate delivery

No delays in getting the units you want. For more information write for a complete catalog—or phone your nearest Dravo sales office and have our representative call on you.

DRAVO

CORPORATION

602 Dravo Building, Fifth and Liberty Avenues, Pittsburgh 22, Pa.

PITTSBURGH • ATLANTA • BOSTON • CHICAGO • CLEVELAND
DETROIT • NEW YORK • PHILADELPHIA

"Journal of Metals," positions that he held from March, 1950 until leaving to take his present position.

J. C. Foster has been appointed assistant chief engineer of construction, Bethlehem Steel Co., Bethlehem, Pa., succeeding **A. J. Fisher,** who recently was made general manager of Bethlehem's Johnstown, Pa., plant. Mr. Foster had been fuel engineer since 1940. **Harold F. Miller** succeeds Mr. Foster as fuel engineer of the Bethlehem, Pa., plant. **R. L. Willis,** assistant fuel engineer since 1949, has been appointed superintendent of construction, Bethlehem plant.

Charles D. Haxby and **S. W. Galloway** have been elected vice presidents of Rust Engineering Co. Before their promotions, Mr. Galloway had been manager of proposals and estimates, while Mr. Haxby was general construction superintendent.

Frank W. Gale was named director of industrial relations for the Nicetown, Philadelphia, Pa., plant of Midvale Steel Co.

Howard D. Turner, assistant superintendent of the inspection department of Lukens Steel Co., Coatesville, Pa., has been appointed to the position of superintendent of Lukenweld division in place of **E. Raymond McClung,** resigned.

HOWARD D. TURNER

W. Frank Kelly was appointed assistant vice president, and **John E. Holtman** was appointed general superintendent of foundries of the American Manganese Steel division, American Brake Shoe Co., Chicago Heights, Ill.

Willard J. Dye was named assistant to the vice president of Hydropress, Inc. and Loewy Construction Co., Inc., New York, N. Y. Mr. Dye was employed for more than 15 years by various departments of the United States Steel Co.

W. Powell, Jr. was named manager of Bailey Meter Co.'s branch office in Buffalo, N. Y. Mr. Powell has been handling the sales and service work of automatic combustion and process control equipment in Philadelphia, Pa., and western Pennsylvania.

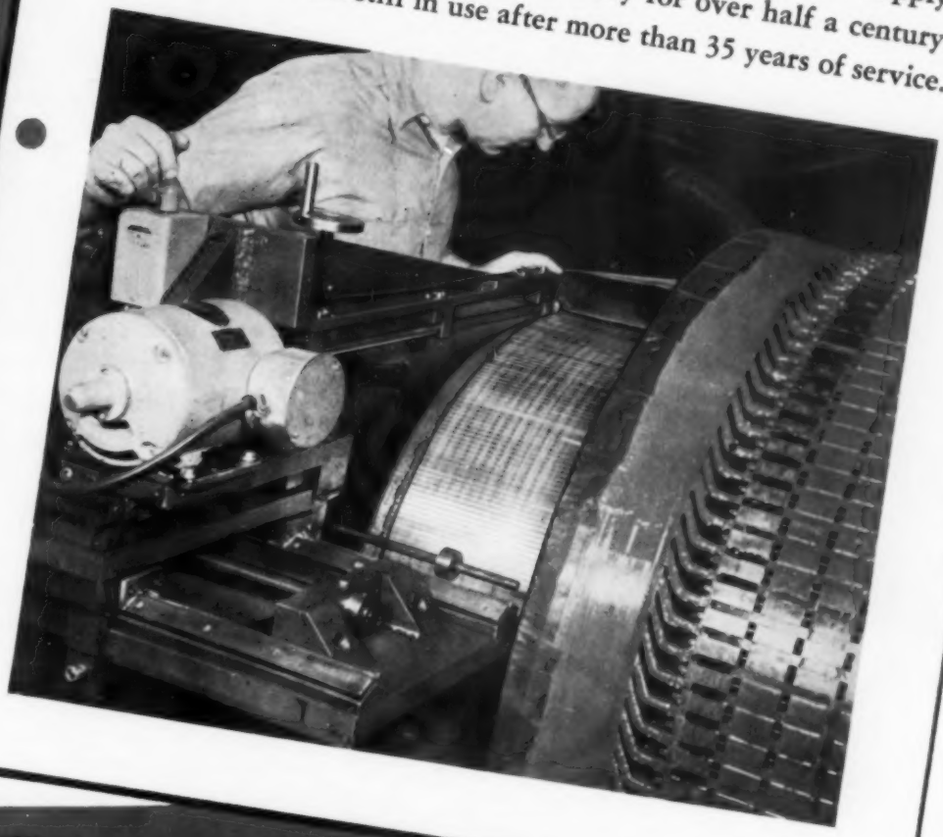
Alfred E. Dorod and **Richard T. Tiebout** have been added to the staff of field engineers for Baker Industrial Truck Division of The Baker-Raulang Co., Cleveland, Ohio.

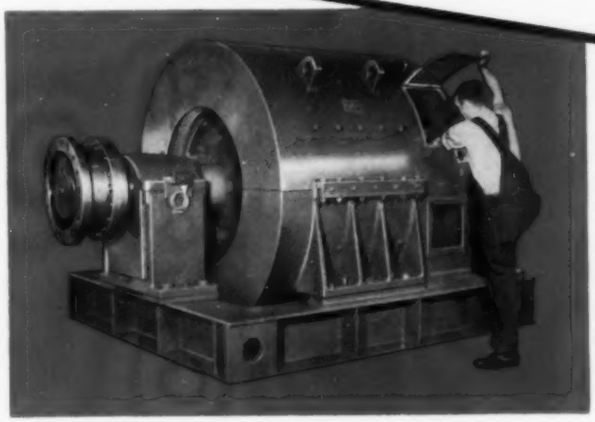
ANOTHER* EXAMPLE OF **ELLIOTT** Excellence IN MOTORS

*Precision Workmanship

in the careful undercutting of commutator mica segments, is characteristic of the painstaking attention to detail which insures dependable performance in Elliott large direct-current motors.

This extreme care in all stages of design and manufacture, is traditional with Elliott motors. Elliott shops have been supplying direct current machines to industry for over half a century. Some of them are still in use after more than 35 years of service.





The Elliott Mill Type DC Motor shown at left is rated 1000 hp, 200/400 rpm, 600 volts, with force ventilation covers including removable hinged doors of clear plastic for ready inspection and maintenance of commutator and brushes. This motor is driving a reversing cold strip mill.

ELLIOTT Company

DEPT. 15

Ridgway Division

RIDGWAY, PA.

R2-7

Plants at: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

George E. Brown has been employed as a sales engineer for graphite products by United States Graphite Co., a division of Wickes Corp. in Saginaw, Mich. Mr. Brown was formerly employed as a metallurgist in the research and development department of the United States Steel Co.'s Gary, Ind., works.

Jess W. Eyler has been appointed to the sales staff of J. K. Mahaffey & Son, Jenkins Arcade Building, Pittsburgh, Pa. Before joining the Mahaffey organization Mr. Eyler was employed at the Westinghouse Air Brake Co., Wilmerding, Pa., as a materials handling engineer.

Robert W. Ellms has been promoted to assistant chief engineer, while **Ted Hatch** has been elevated to supervisor, research and development department, machine division, Osborn Manufacturing Co., Cleveland, Ohio. Both men were engineers in that division.

Foster W. Lamb was named general sales manager for the Automatic Transportation Co., Chicago, Ill. Mr. Lamb had been general sales manager for Templeton, Kenly and Co. in Chicago.

FOSTER W. LAMB

George F. Walsh has been appointed sales promotion manager for Gould-National Batteries, Inc., Trenton, N. J. For the past four years he had occupied a similar position with Baldwin-Lima-Hamilton Corp. at Eddystone, Pa.

George C. Wilder was elected vice president and assistant general manager of Macwhyte Co., Kenosha, Wisc. Mr. Wilder has served as assistant to the general manager since January, 1949.

John K. Beidler was appointed general manager of the machinery division of Dravo Corp., Pittsburgh, Pa. He was also elected a director and a vice president of Dravo-Doyle Co., a subsidiary. In taking over general managership of the Machinery Division, Mr. Beidler fills a vacancy created by the death of Walter P. Berg.

Robert Hughes was appointed engineering manager of Dravo Corp.'s engineering works division, Pittsburgh, Pa. Mr. Hughes was executive assistant to the general manager of the engineering works division and previously had served as assistant director of industrial relations.

Gordon Kimball was appointed as representative and tool engineer for Kennametal, Inc., in the New England area working out of the office at 1537 Main Street, Springfield, Mass. **Thomas Fry** has been appointed application engineer in the Middle Atlantic district working out of Kennametal's Philadelphia, Pa., office.

Tom Turner, who had been vice president in charge of industrial relations for Westinghouse Electric Corp. and who had staff responsibility for headquarters manufacturing, becomes vice president in charge of the motor and control division at Buffalo, N. Y. **T. I. Phillips,** who until recently headed the company's East Pittsburgh, Pa., divisions, succeeds Mr. Turner as staff vice president in charge of manufacturing. Elected vice presidents by the board of directors were **Robert D. Blasier** and **John E. Payne.** Mr. Blasier, who had headed the company's law department office here, becomes vice president in charge of industrial relations and a member of the president's headquarters staff. Mr. Payne becomes vice president in charge of the company's central sales district, with headquarters in Pittsburgh, Pa. He had been manager of the same district. At Buffalo, Mr. Turner succeeds **L. R. Botsai,** who resumes the responsibility he previously held as manager of the company's gearing division in Pittsburgh. **G. H. McBride,** who has served in Mr. Botsai's absence as manager of the gearing division, resumes his previous position as sales manager of that division.

William J. Fitzburgh was elected president and **Willis P. Thomas** was elected chairman of the board of Diamond Power Specialty Corp., Lancaster, Ohio. Mr. Fitzburgh was elevated to the presidency from the position of executive vice president, a post he had held since March, 1950.

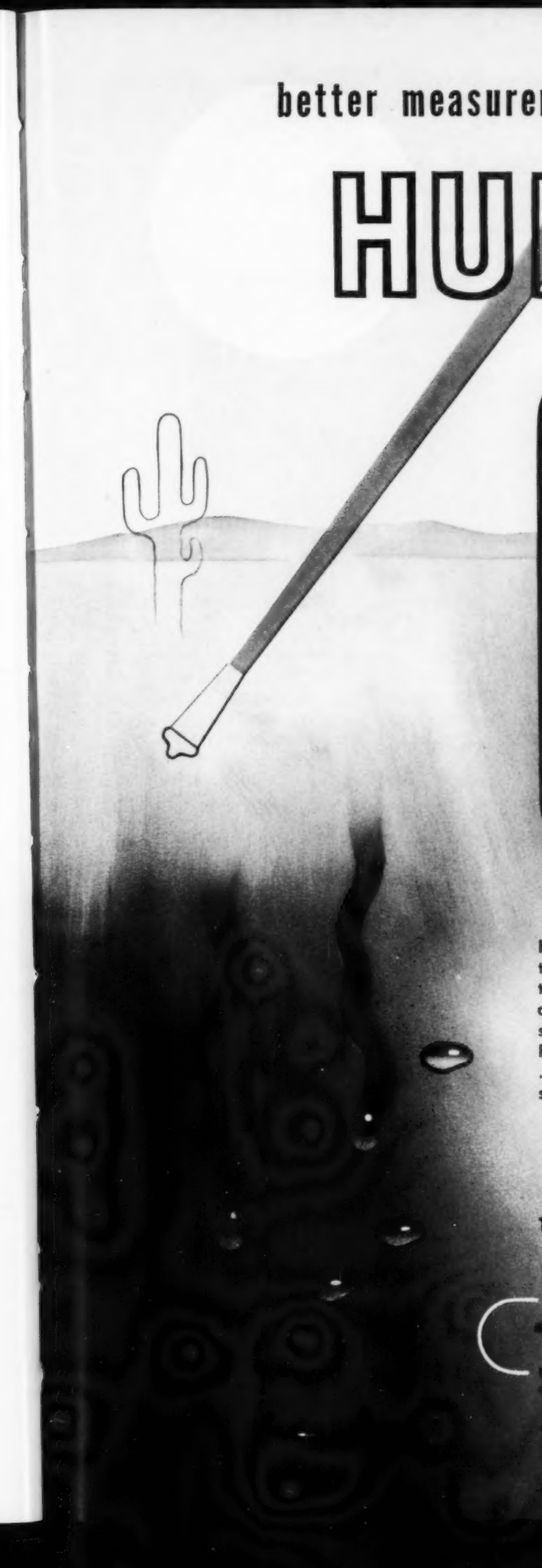
John M. Phillips, Sr., formerly president of the Phillips Mine and Mill Supply Co., Pittsburgh, Pa., was advanced to chairman of the board. **John M. Phillips, Jr.,** formerly vice president and general manager, was elected president. **James M. Phillips** will be the new vice president and general manager. **D. A. Beck** also was named a vice president. He will direct purchases and also will serve as assistant secretary-treasurer. **J. E. Roth** will continue as secretary-treasurer.

Leonard T. Sylvester, president and managing director of Mathews Conveyer Co., Ltd., a Canadian subsidiary of Mathews Conveyer Co., was elected president of the parent company, succeeding the late **William L. Dean. Odd H. McCleary,** vice president, was elected to the office of vice president and general manager. **Lee Sekulski,** sales manager, was elected to the board of directors. **Frank E. Moore** remains in his position as chairman of the board. Mr. Sylvester will continue as president of Mathews Conveyer Co., Ltd., Port Hope, Ontario, residing in Port Hope, and directing the Canadian organization. Mr. McCleary will be in complete charge of all operations at the Ellwood City, Pa., plant. There was no change in the management of the Pacific Coast subsidiary, Mathews Conveyer Co., West Coast. **P. W. Brown** will continue as president and general manager of that company operating at San Carlos, Calif.

Donald E. Dixon, former power and maintenance

better measurement and control of

HUMIDITY



Ever since the origination of accurate humidity control by Foxboro, this Company has been foremost in the development of instrumentation for absolute humidity, relative humidity, moisture content and dew point . . . whether in gas, air, bulk materials or moving sheet stock. The high quality standards and complete diversity of Foxboro Instruments . . . backed by Foxboro's broad experience . . . offer you unmatched facilities for obtaining the most efficient system for your operation.

INDICATORS • RECORDERS • CONTROLLERS

hygroscopic, wet-and-dry bulb, capacitance, plus the unique "Dewcel" system for continuous recording and control of either absolute humidity or dew point.

TRANSMISSION SYSTEMS • CONTROLLED VALVES

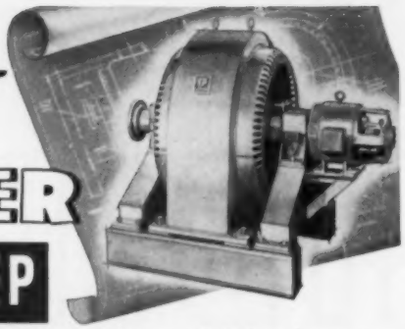
FOXBORO

Reg. U. S. Pat. Off.

For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY, FOXBORO, MASSACHUSETTS, U. S. A.

for custom-engineered POWER look to... EP



• Since 1909, our job has been to create and develop special electrical rotating equipment. This specialization assures equipment designed and built to your exact requirements... guarantees greater dependability, longer life, less maintenance.

Return coupon for information on our Custom-Engineered a-c and d-c motors and generators . . . induction motors . . . battery chargers . . . frequency changers.

Our nation-wide sales engineering and service organization stands ready to meet all User requirements.

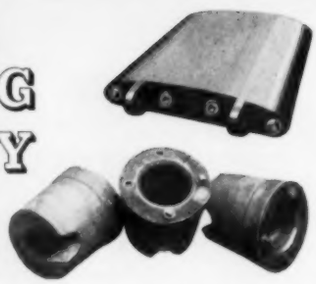
THE ELECTRIC PRODUCTS CO.
1718 CLARKSTONE ROAD
CLEVELAND 12, OHIO

Attach coupon to your letterhead for your copy of Bulletin 2-200.

NAME_____
TITLE_____
COMPANY_____
STREET_____
X-75 CITY_____ ZONE_____ STATE_____

ANOTHER FALCON CONTRIBUTION

TO OPERATING EFFICIENCY



If air could conduct heat better than water, you would circulate air through your copper cooling plates. But you are aware of what trapped air does to a tuyere or to a bosh plate. It has been a major threat to operating efficiency . . . and Falcon non-ferrous casting specialists have come up with the answer.

Falcon has created an AIR-FREE COOLING PLATE and an AIR-FREE TUYERE.

It is another of the many examples of Falcon pioneering . . . constantly affording you the current best in copper castings, through specialization . . . and contributing immeasurably to longer equipment life and maximum reduction of down-time.

For Blast Furnace Copper Castings delivered when you want them . . . and in the best quality

Telephone Collect 3-4186

FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 - Incorporated 1895

Licensed Manufacturers of All Patented Designs

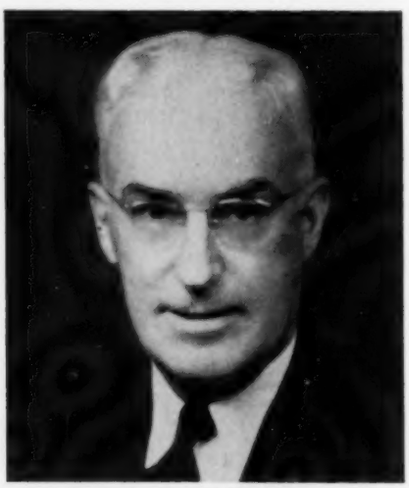
DEPENDABLE FOR 61 YEARS · SINCE 1890

engineer for various Colorado municipal and industrial power plants, has been appointed service representative for Hagan Corp. automatic combustion controls and Hall water treatment in the Denver, Colo., district.

Edward J. Helm, technical engineer in the sales department, Engineering and Construction Division of Koppers Co., Inc., for the past two years, has been promoted to the position of manager, patent and development section of the division.

EDWARD J. HELM

W. R. Yorkey has been appointed sales manager of Electric Controller & Mfg. Co., Cleveland, Ohio. **R. J. Lincoln** will succeed Mr. Yorkey as district manager of the New York, N. Y., office. Mr. Yorkey started with EC&M in 1918 and has been New York district manager for several years. Mr. Lincoln has been in the New York office since he joined the company in 1931.



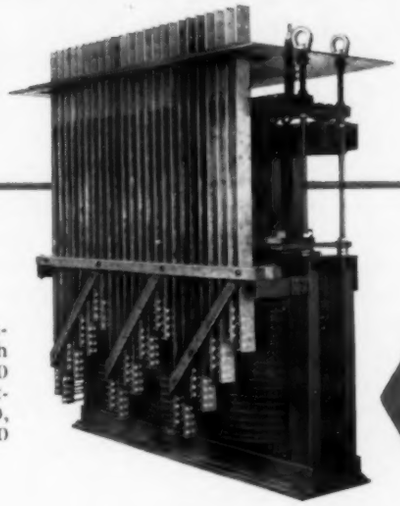
W. R. YORKEY

Henry P. Berry has been named southern regional manager for the Insul-Mastic Corp. of America. Mr. Berry will make his headquarters in New Orleans, La.

Ross C. Cibella has been appointed personnel manager of Hagan Corp. and subsidiaries, Pittsburgh, Pa. Mr. Cibella joined Hagan Corp. in 1937 as technical librarian. The Hagan library is regarded in industry and among professional library people as a model collection of technical and professional information on combustion and chemical engineering, boiler water conditioning, industrial water problems and processes, municipal and marine water technology.

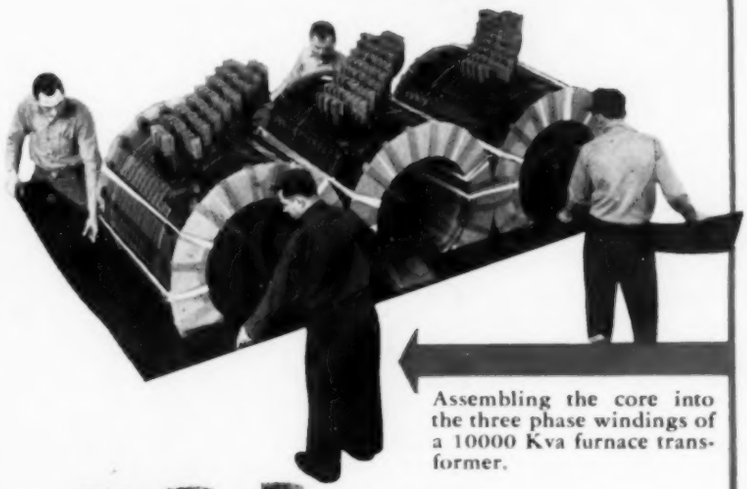
NOW *15 years of Proof*

behind the design of each PENNSYLVANIA FURNACE TRANSFORMER



2500 Kva Transformer; High voltage — 3300 volts; Low voltage — 140, 130, 120, 110 and 100 volts.

Fifteen Years Ago... Pennsylvania Transformer Company introduced a new type of helical winding in the low voltage coils of a 2500 Kva furnace transformer. Since then, Pennsylvania has manufactured over 1¼ million Kva of furnace transformers using the same fundamental principles of design employed in this 2500 Kva unit.



Assembling the core into the three phase windings of a 10000 Kva furnace transformer.

In all the intervening years, there has *never* been a low voltage winding breakdown on any of these furnace transformers. Because this design is basically and fundamentally correct, Pennsylvania can build furnace transformers for any size electric furnace now being manufactured or being contemplated for future construction.

Low voltage side. 25000 Kva furnace transformer.

Pennsylvania
TRANSFORMER COMPANY
CANONSBURG, PA.
Greater Pittsburgh District

Pennsylvania TRANSFORMERS

Harvey L. Cadwallader, sales engineer of Electric Service Manufacturing Co., Philadelphia, Pa., has been named district manager of the company's Pittsburgh, Pa., office in the Investment Building. Mr. Cadwallader, a member of the Philadelphia sales staff, has been with Electric Service for the past 12 years. He fills the position left vacant by the death of Bernard A. Gallagher.

William N. Horko, formerly furnace engineer for Henry Disston and Sons, Inc., Philadelphia, Pa., has opened an industrial engineering office. In his consultant services, Mr. Horko will specialize in the design and layout of industrial heating and treatment equipment. He will be located at 1015 Cherry St., Philadelphia, 7 Pa.

Obituaries

John C. Reed, 76, died January 30 in a hospital at Harrisburg, Pa. Mr. Reed was, before his retirement, superintendent of the electrical department of Bethlehem Steel Co., Steelton, Pa. Mr. Reed was a past president of the Association of Iron and Steel Engineers serving in 1909.

Eugene Friedlander, former electrical superintendent, of U. S. Steel Co.'s Edgar Thomson works, Braddock, Pa., died recently. Mr. Friedlander was a past president of the Association of Iron and Steel Engineers, serving in 1914.

Walter P. Berg, 60, vice president and director of Dravo Corp., Pittsburgh, Pa., died February 3. Associated with Dravo Corp. for 30 years, Mr. Berg also was a member of the firm's executive committee and general manager of the machinery division.

F. C. Biggert, Jr., 73, chairman of the board of United Engineering and Foundry Co., Pittsburgh, Pa., and one of the pioneers in the design of continuous strip mills for the steel industry, died February 10. Mr. Biggert was graduated from the University of Pittsburgh in 1899 as a mechanical engineer. He joined the Frank-Kneeland Machine Co. which, two years later, helped form the United Engineering and Foundry Co. He was made chief engineer of the new firm in 1913 and rose to president and general manager in 1919. In 1943, he was elected chairman of the board of directors.

A. B. Frost, superintendent, roll department, Kaiser Steel Corp., Fontana, Calif., died recently.

Morris E. Leeds, 82, founder and chairman of the board of Leeds & Northrup Co., died February 8 at Lake Wales, Fla.

F. L. Ebersole, engineer for Detroit Steel Corp., Portsmouth, Ohio, died January 19.

A. K. McMillen, 77, died February 4. Mr. McMillen was formerly chief engineer of Alexander Laughlin Engineering Co., Pittsburgh, Pa., and director of the old Central Tube Co.

Walter J. Mullally, sales representative for American Manganese Steel division of American Brake Shoe Co. died February 17. Mr. Mullally joined the engineering department of American Manganese Steel in 1919 and later transferred to the sales department. He was located in Chicago, Ill.

C. A. Kral, vice president in the Engineering and Construction Division of Koppers Co., Inc., died suddenly in New York, N. Y., January 31. For the past several years, Mr. Kral had been Chilean management representative for Koppers at the Pacific Steel Co., of Chile, residing in that country. He returned to the United States a few months ago and was to have gone back to Chile shortly.

During his steel mill career Mr. Kral was with Otis Steel Co., Wheeling Steel Corp., Jones & Laughlin Steel Corp., and Newport Steel Co.

Walter H. May, 71, formerly chief electrician, Ohio and Western Pennsylvania Dock Co., Cleveland, Ohio, died January 30.

William L. Dean, 67, president of Mathews Conveyer Co., Ellwood City, Pa., died February 6, 1952 in St. Petersburg, Fla. after an illness of one year. Mr. Dean started with Mathews in 1909 as a shipping clerk and held various executive positions until he became president in 1948. Mr. Dean was well known in the material handling equipment field, and served as president of the Foundry Equipment Manufacturers Association for the year of 1949.

JOHN C. REED

EUGENE FRIEDLANDER

WALTER P. BERG

F. C. BIGGERT, JR.

SQUARE D FIELD ENGINEERING *in Action!*

PROBLEM To design a panel that would automatically control, sequence and indicate the progress of the entire charging operation for this #2 blast furnace located at the Clairton Works of United States Steel Company.

SOLUTION

Square D designed and built this simple and easily maintained master panel to control and sequence existing motor starters—utilizing standard components from Square D's complete line of heavy duty equipment. One man now controls the entire charging operation from a master station . . . a typical example of Square D field engineering in action — conserving materials, time and effort while increasing the factor of safety.

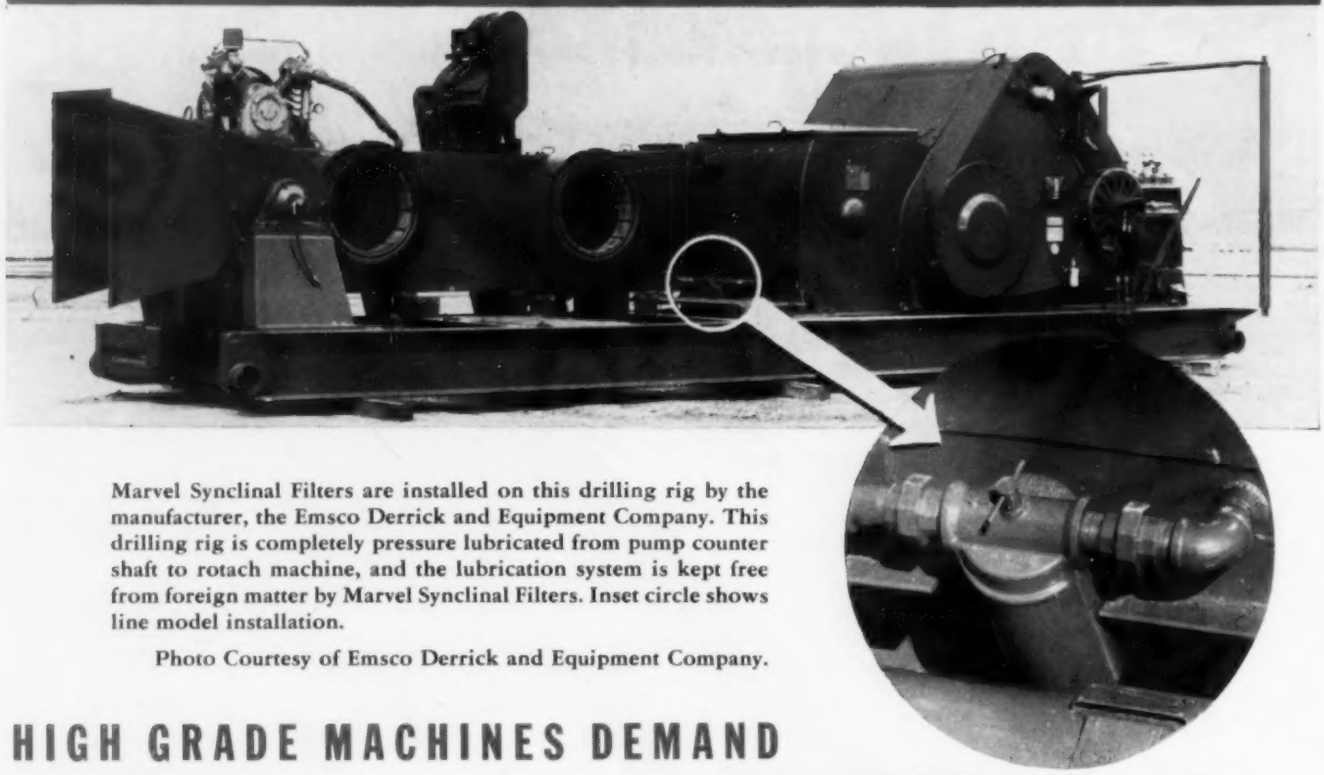
SQUARE D FIELD ENGINEERS ARE AT YOUR SERVICE
THROUGH BRANCH OFFICES IN ALL PRINCIPAL CITIES

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S. A., MEXICO CITY, D. F.

ANOTHER MANUFACTURER SPECIFIES
MARVEL SYNCLINAL FILTERS



Marvel Synclinal Filters are installed on this drilling rig by the manufacturer, the Emsco Derrick and Equipment Company. This drilling rig is completely pressure lubricated from pump counter shaft to rotach machine, and the lubrication system is kept free from foreign matter by Marvel Synclinal Filters. Inset circle shows line model installation.

Photo Courtesy of Emsco Derrick and Equipment Company.

HIGH GRADE MACHINES DEMAND THE BEST FILTER PROTECTION

That is why over 260 Original Equipment Manufacturers, like Emsco, specify Marvel Synclinal Filters as oeiginal equipment; thus they assure their machines longer life, operating with all the productive efficiency built into them by the makers.

Less Maintenance plus Greater Efficiency
equals **MORE PRODUCTION**

That is the reason why a great many machine manufacturers and users are specifying Marvel Synclinal Filters because they offer the greatest amount of ACTIVE filtering area within the smallest amount of space, allow longer periods of operation between cleaning and are so simply designed that any workman can quickly disassemble, clean and reassemble on the spot. Sturdily constructed, Marvel Synclinal Filters have no moving parts, no complicated assembly to require special attention. Line models operate in any position and may be serviced without disturbing pipe connections.

5 to 100 G.P.M. Sizes in Sump and Line Types

Both models are available in mesh sizes from 30 to 200. For efficient filtration of non-corrosive liquids in all hydraulic and low pressure systems, Marvel has the right filter protection for your machine.

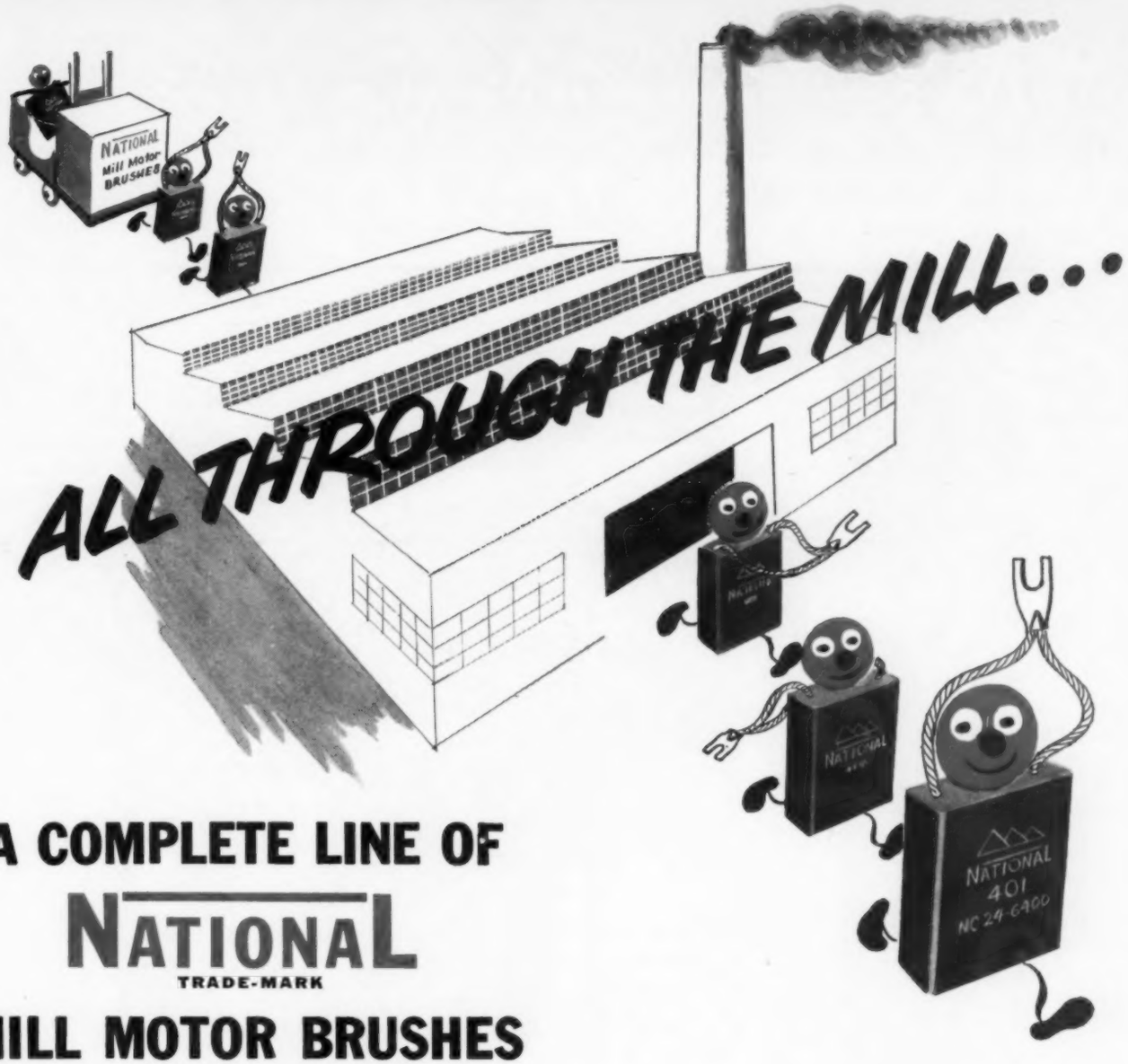
Sump Type (Cutaway)

Line Type (Cutaway)

For complete Engineering Data write for Folder 105

Meets J.I.C. Standards

MARVEL ENGINEERING COMPANY
625 W. Jackson Blvd. Chicago 6, Ill.



A COMPLETE LINE OF NATIONAL TRADE-MARK MILL MOTOR BRUSHES BUILT TO AISE STANDARDS

FRESH attention was focused on industry-wide carbon brush standardization by the recent publication of AISE standard dimensions for all 230V DC Mill-Type Motors.

National Carbon Company has now published a complete list of "National" Mill Motor Brushes, corresponding to *all* the new AISE Standards. GET THIS LIST! From it you can order "National" brushes for *every mill motor in your plant.* Made up in service-proved brush grades that have been "through the mill" for years, they incorporate the latest improvements in tamped-type shunt connections to withstand severe vibration.

Moreover, the more frequently ordered types and grades have been designated "National" STANDARDIZED BRUSHES. They are available from stock at the same low unit price for 100 or 100,000.

The ball is rolling. Let's all PUSH for still further *standardization* of replacement items for *standard* equipment. It means simpler, surer, more efficient operation for YOU!

The term "National" and the Three Pyramids device are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg

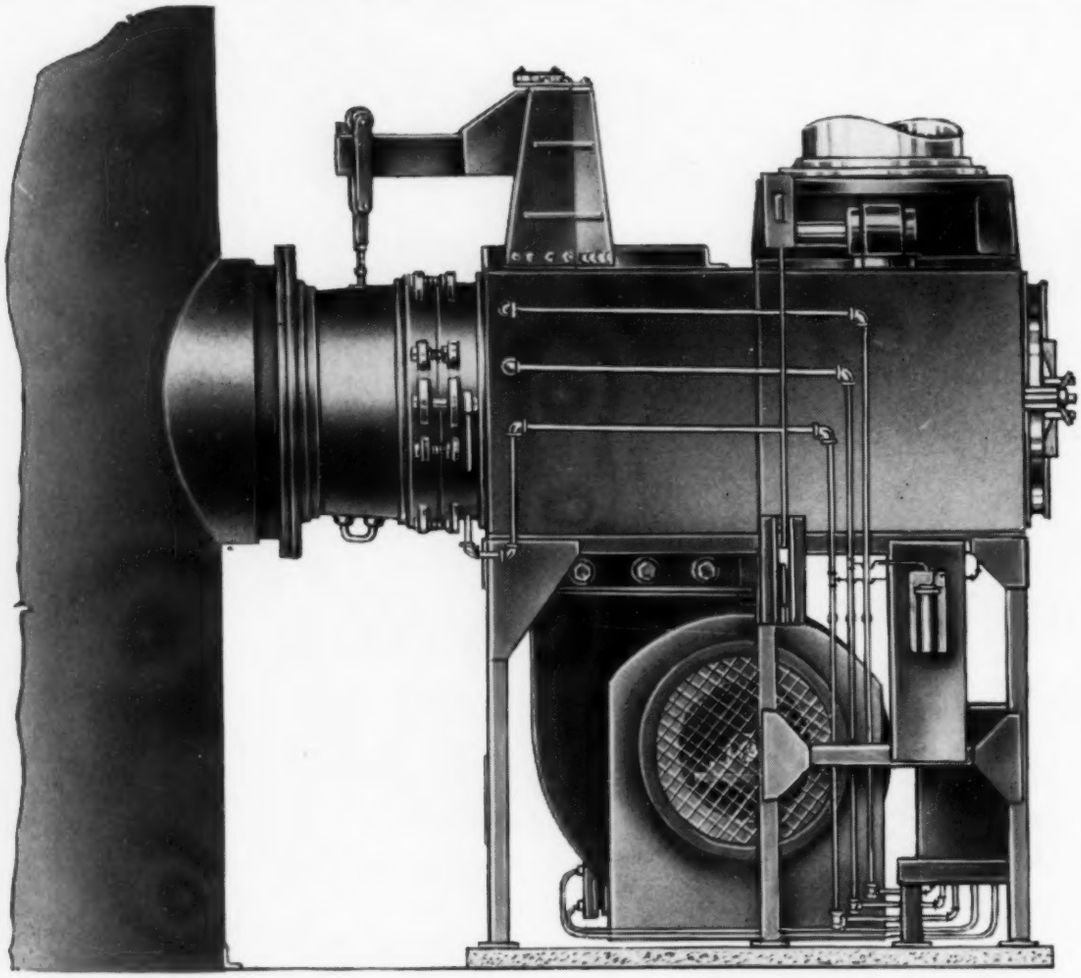
AISE standard numbers for "National" STANDARDIZED Mill Motor Brushes

NC NUMBER	AISE STANDARD NUMBER
20-4800	STD NO. 21
20-5600	STD NO. 25
24-4800	STD NO. 29
24-5600	STD NO. 30
24-6400	STD NO. 32

Write for a complete list of "National" Mill Motor Brushes built to AISE standards

Ideal Combustion Conditions for

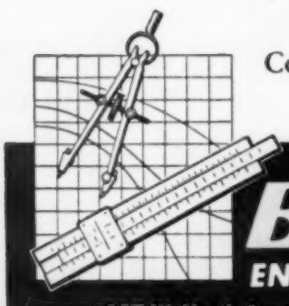
MAXIMUM STOVE CAPACITY!



The **BLOOM-PAULSEN-STEINBART**

BLAST FURNACE STOVE BURNER

Automatic proportioning of air and gas at the ratio you select provides combustion conditions that assure correct temperature distribution for maximum stove heating capacity. Compact, sturdy construction; easy to operate and flexible.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

Write for illustrated bulletin giving full details and operating data.

Publication Service...

MARCH, 1952

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Instrument Transformer Guide

The 1952 edition of the Instrument Transformer Buyer's Guide, containing basic, up-to-date information on the complete line of General Electric instrument transformers, has just been released. The fully illustrated, 94-page publication gives ratings, ASA accuracy classifications and prices of all G-E indoor and outdoor potential and current transformers, metering outfits and potential and current portable transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers, are also included. (GEA-4626E) General Electric Co.

(2) Standby Emergency Power

Featured in "E-M Synchronizer" No. 35, quarterly publication, available to you, of the Electric Machinery Mfg. Co., is an article on standby or emergency power. This article deals with the requirements of standby power, the types of service available, and a detailed discussion of controls for automatic start-stop operation. It is also fully illustrated with diagrams and typical installation pictures. Other articles in the Generator Number of the "E-M Synchronizer" include a discussion of turbine generator construction features—a generator selection chart, plotted to give generator kva necessary when motor hp and allowable voltage drop are known—a "Handy Selection Index for Engine-Driven A-c Generators" which lists in tabular form the ratings, description, applications, and specifications of the various types of generators—and a short illustrated description of "Walkway" type generator switchgear.

(3) Synchronous Motors

"Application of Direct-Connected Synchronous Motors to Reciprocating Compressors" is a reprint of a paper presented at the New York Section of AIEE. This discussion deals largely with consideration of proper rotor flywheel effect (WK^2) as a preventive measure for voltage fluctuations when driving reciprocating compressors with direct-connected synchronous motors. Examples complete with formulas, sample calculations, and reference curves are included in this booklet. A worthwhile addition to the engineers reference library, this 12-page technical article is available. (1200-TEC-1111) Electric Machinery Mfg. Co.

(4) Cam Programmer Thermometers

A new catalog, "Cam Programmer Thermometers," describes a compact efficient approach to the problem of time-temperature control. The catalog describes and illustrates the use, advantages, technicalities and versatility of this new instrument that combines as many as six functions from a standard sized instrument case. (6020) Brown Instruments Division, Minneapolis-Honeywell Regulator Co.

(5) Case History

An eight-page case history describing the operation of the largest independent producer of electric power for manufacturing in Connecticut, Scovill Manufacturing, is now available. The equipment and operating philosophy which enabled this plant to achieve an evaporation rate of 12.8 and a cost per thousand pounds of steam of $0.706 is fully covered. Use of steam, fuel and ash handling, and plant steam demand are discussed and illustrated. A large schematic drawing reveals the operation of the combustion control system; in addition, a drawing of the instrument panel is tied into actual photographs of functions performed by particular controllers. (R-8) Hays Corp.

(6) Automatic Bundling

A new four-page catalog describing two new heavy-duty packaging machines has been announced as available. The catalog provides detailed information and pictures on new automatic bundling and reinforcing equipment. The equipment is described as being "an answer to faster and more economical heavy-duty packaging." Complete specifications and pricing information is also listed for each machine, along with the manufacturer's recommendation for the use of pressure-sensitive filament tapes. Guide Co.

(7) Modern Lighting Maintenance

A new 12-page bulletin, "The Why, When and How of Modern Lighting Maintenance" is now available. Emphasizing the high cost of low lighting maintenance standards, the bulletin stresses that planned maintenance of both light sources and reflecting surfaces saves costly time and useful light. The bulletin outlines an 8-step program of planned fluorescent lighting maintenance suggesting: (1) check lighting levels regularly, (2) replace burnouts promptly, (3) keep lamp and reflectors clean, (4) replace lamps systematically, (5) maintain light colored walls and ceilings, (6) maintain proper line voltage, (7) keep a stock of fixture parts, and (8) use labor saving methods and equipment. Particularly stressed are the advantages of planned group replacement of lamps as compared to "one-at-a-time" replacements. Lighting Division, Sylvania Electric Products, Inc.

(8) Rust Preventive

A 16-page general catalog is available listing Rust-Oleum rust preventive application. Of particular importance is the fact that this rust preventive features the use of color chips throughout to illustrate exact color. Detailed information and technical data complete with applications, resistance qualities, drying time, thinners and special applications are included with each. This booklet should be in every maintenance department library. (251) Rust-Oleum Corp.

(9) Continuous Sampling Monitor

A new four-page bulletin on the continuous sampling monitor, a new device to simplify quality control, has been announced as available. The booklet (GEA-5738) contains photographs and diagrams of the equipment and explains the continuous sampling monitor's operation, construction and range. It is designed to complement a bulletin (GEA-5627) on quality control instrumentation. General Electric Co.

(10) Explosion-Proof Motors

Construction details of Allis-Chalmers explosion-proof, fan-cooled and non-ventilated motors are described in a new bulletin released by the company. These fan-cooled Type APZZ motors are available in ratings of 3 to 100 hp and the non-ventilated Type APKK in ratings from ½ to 2 hp. They meet all requirements of, and are approved by, Underwriters' Laboratories, Inc., for use in Class I, Group D, and Class II, Groups F and G atmospheres. Due to the elimination of enclosed external air passages, the motors are easy to keep clean. This feature, together with an efficient cooling system, makes them suitable for use where there is dust, dirt, fly ash, rain, snow, or corrosive gases. (51B-7286A) Allis-Chalmers Manufacturing Co.

(11) Power Transmission

Pointing up the efficiency-improving, cost-reducing advantages that packaged, all-electric, adjustable-speed drives bring to a wide range of production machines and processing equipment, a new, 8-page, attractively-illustrated booklet has just been issued. The booklet presents a simplified, easy-to-read, non-technical explanation of the "V*S" Drive, its "economics," application versatility, and operational flexibility in providing adjustable speeds from a-c circuits. Briefly discussed are seven basic functions of this effective method of power transmission, available in drives of five types ranging in ratings from ¾ all the way up to and including 200-hp. Application of this equipment to seven typical manufacturing operations in as many industries also is illustrated. Supplementary information includes diagrammatic and tabular charts covering basic speeds and horsepower-torque characteristics of the drive. (D-2311) Reliance Electric & Engineering Co.

(12) Cemented Carbide

A new catalog listing the Newcomer line of standard and special cemented tungsten carbides is available. The catalog is written in semi-technical terms to provide complete information on standard blanks, standard tools, adjustable clamp tools, carbide milling data, cutting and grinding data, prices and other useful information. Greenleaf Corp.

(13) Control Circuit Cable

Literature is available describing how pneumatic and hydraulic control circuits may now be streamlined through the use of "Armortube" cable, a flexible, protected multi-tube transmission line. This unique cable is made up of ¼ in. outside diameter aluminum or copper tubing gathered in a slow continuous spiral similar to the construction of rope. A tube bundle is first wrapped in water-repellent insulating tape; then encased in heavy rust-resistant, galvanized steel strip like that used for BX electrical cable. (BA-927) Bailey Meter Co.

(14) Rotary Pumps

A bulletin is available describing the new De Laval A313B "Imo" rotary pump. The new pump is a general service screw-type rotary pump designed for handling petroleum products, and other light viscous fluids as required for hydraulic systems, rotary and steam atomizing oil burners, lubrication, governing systems and similar services. Capacities to 80 gpm, pressures to 275 psi (continuous) and to 325 psi (intermittent). The bulletin contains a cutaway section of the pump, complete description, viscosity tables and dimensions for various frame sizes. The main features of the pump include: pulsation free flow, mechanical shaft seals, pre-lubricated bearings, and optional types of mountings. It can be mounted in any position and be driven by direct connected shaft, V-belts or chains. (L-313-B) De Laval Steam Turbine Co.

(15) Conduit Products Selector

A new conduit products selector has been produced by General Electric's construction materials division. The selector, designed to aid the electrical contractor, electrician, inspector and maintenance man, computes the allowable conduit fill for various sized rubber, thermoplastic, or lead-covered conductors by a simple dialing operation. The reverse side of the selector uses the same technique to figure number of conductors allowed in the most commonly used outlet, switch, and utility boxes. All tables used in the selector are from the 1951 National Electrical Code. (18-111) General Electric Co., Construction Materials Division.

(16) Water Systems Counsel

"The Pittsburgh Service for Water and Waste Water Systems" is title of 4-page folder which outlines briefly the service, counsel and engineering skill offered to aid you in getting highest efficiency from your water and sewage systems. Pittsburgh Pipe Cleaner Co.

(17) Electrolytic Motor-Generators

A bulletin is available that describes in 14 pages with 43 illustrations a complete line of low-voltage, direct-current motor-generators for electrolytic processes. Not only are both sleeve-bearing and ball-bearing constructions presented, but also a short history of the development of today's electrolytic motor-generators and several electroplating fundamentals. (20-210) Electric Products Co.

(18) Chemical Treatment

A chemical treatment, "Rustshield 2," that produces an oil-retaining rustproof surface for moving metal parts, is described in a new publication. Attractively printed in two colors, the booklet discusses application methods and advantages of using this chemical on sliding and bearing surfaces. Octagon Process, Inc.

(19) Standardized Brushes

Anticipating wide-spread acceptance of the Association of Iron and Steel Engineers standards for mill motor brushes, National Carbon Co. has ready for immediate distribution a new bulletin No. CP-2444 listing a complete line of mill motor brushes built to conform to AISE standard specifications in every particular. The bulletin lists all of the standard numbers and code numbers, the corresponding "National" brush numbers, brush sizes and grades. Each brush is designed to give maximum performance on the particular motors specified by the standard, and each

brush is designed to sell for the lowest possible price. "National" Grades AX-5 and 401 are applicable to such a wide range of operating conditions that only one or the other of these two grades need be used for the several mill motor types to which each brush size applies. Both grades have a long and outstanding record of success on mill-type motors, unsurpassed among all brush grades. Shunt connections are a rugged, low-resistance, vibration-proof, tamped type. Many of the brushes are shipped from stock and the remainder are set up for quick fabrication in the factory. The five most popular items are available as "National" standardized brushes at the same low standard package price 100 as for 100,000 brushes. National Carbon Co., a division of Union Carbide and Carbon Corp.

(20) Buyer's Guide

The entire line of general-purpose and specialized "Thermohms" (resistance thermometers) that are being used in countless plant and laboratory applications to detect temperatures between −325 and +1000 F with accuracies from ±0.018 F to ±3.0 F are fully described and illustrated in a new, 36-page catalog and buyer's guide, "Thermohms, Assemblies, Parts and Accessories," just published. To aid in the choice of the correct "Thermohm," this publication features a 5-page tabular guide which indicates the Thermohm to use for each of the numerous industrial applications. This guide also describes how the thermometer is used and tells where it is usually installed. Many additional pages provide information about the temperature conditions, corrosive agents, pressures, gaseous or liquid flows, and other process conditions to which the elements can be exposed. Illustrations also show many of the typical applications and the ways in which Thermohms are installed. (EN-S4) Leeds & Northrup Co.

(21) Air and Hydraulic Circuits

A 32-page, pocket-size manual, presenting a discussion of basic designs in fluid power circuits together with drawings, has been announced. In preparing this manual, the company has endeavored to bring to industry a down-to-earth explanation of representative types of fluid power circuits and to show the many possibilities afforded through the use of different types of circuit designs. This new manual, entitled "The Circuit Rider," is now available. Logansport Machine Co.

(22) Butterfly Valves

A new 12-page catalog covers the use of Honeywell "Air-O-Motor" diaphragm operators with Continental butterfly valves. Complete specification data is given for both standard and heavy duty pattern valves. A wide selection of diaphragm operators is shown and described. Also included are material specifications, mounting dimensions, maximum pressure ratings and easy-to-follow selecting and ordering information (1700) Brown Instruments Division, Minneapolis-Honeywell Regulator Co.

(23) Speed Reducers

Two very fine books are available on speed reducers. The first is on worm gear speed reducers and includes information on the various types of worm gear reducers, construction and design details, ordering data, selection information, weights and ratings, dimensions, and lubrication data. A section is also devoted to couplings. The second booklet is on herringbone gear speed reducers. This booklet contains the same type of information as the first book. (114 and 115) Brad Foote Gear Works, Inc.

(24) Welding Reprints

Three new reprints of articles on Aircomatic welding have been announced by Air Reduction Sales Co., a division of Air Reduction Co., Inc. These articles originally appeared in "The Welding Journal" and were given before the annual meeting of the American Welding Society. "Aircomatic Welding of Austenitic Stainless Steels" a 16 page article by W. G. Benz, Jr., and J. S. Sohn, presents the results of an investigation of the mechanical properties and corrosion resistance of austenitic chromium-nickel grades of stainless steel weld metal and welded joints deposited with the inert-gas-shielded metal-arc process. "Aircomatic Welding Refinery Components and Pressure Vessels" by Stephen A. Yaczko describes procedures for welding stainless, stainless clad steel, low-alloy steel and copper-alloy pressure vessels with the inert-gas-shielded metal-arc process. "Inert-Gas-Shielded Metal-Arc Welding of Magnesium" by Paul Klain describes an investigation conducted to evaluate the application of the inert-gas-shielded metal-arc process to the welding of magnesium. (Form ADR 75, 76, and 77.)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

MARCH, 1952

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	50	51	52	53	54	55	56	57	58	59	60			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76			
77	78	79	80	81	82	83	84	85	86									

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MANUFACTURING CO.	BULLETIN G-2-51	Describes the complete series of cable support fittings.
51	ALDRICH PUMP CO.	DATA SHEET 61-2	Facts on Aldrich spray nozzles.
52	AMERICAN BRAKEBLOK DIVISION, AMERICAN BRAKE SHOE CO.		Folder available on A-B-K bearings.
53	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.		Catalog obtainable on dollar-saving Amsco electrodes.
54	BAILEY METER CO.	BULLETIN 230-C	Full story on Pyrotron electronic resistance thermometers.
55	BLOOM ENGINEERING CO., INC.		Illustrated bulletin on blast furnace stove burners.
56	BRISTOL CO.	CATALOG P1245	Information on how Dynamaster can solve your measurement problems.
57	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Describes Browning mill type cranes.
58	DRAVO CORP.		Complete catalog available on Dravo crane cab coolers and conditioners.
59	DURABLA MANUFACTURING CO.	BULLETIN 9 S 3	Information available on Durabla valves.
60	ELECTRIC PRODUCTS CO.	BULLETIN 2-200	Complete data on Electric Products' custom-engineered power.
61	ELECTRIC SERVICE MANUFACTURING CO.		Catalog available on Keystone collectors.
62	ELLIOTT CO., CROCKER-WHEELER DIVISION		Mill motor bulletin available.
63	FOOTE BROS. GEAR AND MACHINE CORP.		Bulletin on Maxi-Power drives.
64	GENERAL ELECTRIC CO.	BULLETINS GEA-5618, GEA-5622, GEA-5512	Describes the G-E magnetic loop control, the x-ray thickness gage and the G-E tensiometer.
65	HOMESTEAD VALVE MANUFACTURING CO.	REFERENCE BOOK 39-3	Complete data on Homestead "Lever-Seald" valves.
66	IDEAL INDUSTRIES, INC.		Handbook on commutator and slip ring maintenance.
67	JOY MANUFACTURING CO.		Literature available on electrical plugs and receptacles.
68	KAISER ALUMINUM & CHEMICAL SALES, INC.		Descriptive literature on Permanente 165 and on the companion ramming mix, Permanente 84.
69	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Catalog available giving detailed descriptions of Fast's couplings.
70	LESLIE CO.	BULLETIN 513	Gives details on Leslie control valves.
71	LINTERN CORP.		Describes Lintern pulpit aire-rectifiers.
72	MARVEL ENGINEERING CO.	FOLDER 105	Complete engineering data on Marvel synclinal filters.
73	OAKITE PRODUCTS, INC.		24-page illustrated bulletin on Oakite solvent detergents.
74	OKONITE CO.	BULLETIN IS-1053	Gives facts on the stability and performance of Okolite-Okoprene.
75	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 7	Complete data on Lectromelt furnaces.
76	POOLE FOUNDRY AND MACHINE CO.		Catalog obtainable on flexible couplings.
77	POST-GLOVER ELECTRIC CO.	BULLETIN 500	Describes P-G steel grid resistors.
78	SPRAYING SYSTEMS CO.	CATALOG 22 AND DATA SHEET 3997	Information on the Spraying Systems descaling nozzle.
79	TAYLOR CHAIN CO., S. G.		Booklet contains all the facts and specifications on TM alloy steel chain and attachments.
80	TRUFLO FAN CO.		Illustrated literature available on Truflo fans.
81	UNITED STATES GRAPHITE CO.		40-page catalog on standard USG grades.
82	WAGNER ELECTRIC CORP.	BULLETIN IU-40	Full information on Wagner crane-bridge brake systems.
83	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4723	Describes the Westinghouse life-line safety switch.
84	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4016	Complete information on Westinghouse metal-clad switchgear.
85	WILSON ENGINEERING CO., INC., LEE		20-page booklet on single-stack portable base furnaces.
86	YODER CO.		Book available on cold-roll-forming.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

MARCH, 1952

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	50	51	52	53	54	55	56	57	58	59	60			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76			
77	78	79	80	81	82	83	84	85	86									

BUSINESS REPLY CARD

First Class Permit No. 1965, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1011 EMPIRE BUILDING
PITTSBURGH 22, PA.

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

Applications for AISE Membership

Active

ALBERT H. ANDREWS
Special Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

ROGER R. BARNES
General Foreman
Tin Plate Mill
Kaiser Steel Corp.
Fontana, Calif.

VERNE H. BROOKS
Assistant Roll Designer
Carpenter Steel Co.
Reading, Pa.

ROY E. BROUSSEAU
Chief Draftsman and Supervisor of Planning Room
Columbia Steel Co.
San Francisco, Calif.

EUGENE CANBY
Junior Engineer
Atlas Steels, Ltd.
Welland, Ontario, Canada

CRIST A. CARAOTTA
Assistant Electrical Foreman
Republic Steel Corp.
Buffalo, N. Y.

RAY E. COATNEY
General Foreman
Mechanical Shops
Kaiser Steel Corp.
Fontana, Calif.

WILLIAM DAVIES
Squad Leader
Design Engineering Department
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

ROBERT W. ENGELBERT
Field Engineer
Republic Steel Corp.
Buffalo, N. Y.

HAROLD R. GORMAN
Special Engineer, Mechanical Maintenance Department
Edgar Thomson Works
United States Steel Co.
Braddock, Pa.

GEORGE P. HANLIN, JR.
Senior Draftsman
Lukens Steel Co.
Coatesville, Pa.

ARTHUR S. HERMAN, JR.
Draftsman
Bethlehem Steel Co.
Sparrows Point, Md.

HAZEN B. HINMAN, JR.
Superintendent
Rome Strip Steel Co., Inc.
Rome, N. Y.

RICHARD JABLIN
Project Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

JOSEPH JACOB
Junior Engineer
Atlas Steels, Ltd.
Welland, Ontario, Canada

GEORGE LATINOVICH
Junior Engineer
Atlas Steels, Ltd.
Welland, Ontario, Canada

HELMUT F. LAUDIEN
Draftsman
United States Steel Co.
Gary, Ind.

EUGENE R. MIZER
Senior Construction Engineer
Armco Steel Corp.
Zanesville, Ohio.

MALCOLM GEORGE MORGAN
Superintendent Continuous Butt Weld Furnaces and Galvanizing
National Tube Co.
Morrisville, Pa.

IWAO MURATA
Chief of Steel Department
Muroran Iron Works of Fuji Iron & Steel Co.
Muroran, Hokkaido, Japan.

JOSEPH A. NAVALANCE
Roller
Compania de Acero Del Pacifico, S. A.
Talcahuano, Chile, S. A.

PAUL E. NELSON
General Foreman
Tin Plate Mill
Kaiser Steel Corp.
Fontana, Calif.

HARRY J. READING
Assistant Superintendent
Tin Plate Mill
Kaiser Steel Corp.
Fontana, Calif.

PETER C. ROMAN
Motor Inspector
Edgar Thomson Works
United States Steel Co.
Braddock, Pa.

R. J. STOKER
Superintendent Galvanize
Gary Sheet and Tin Mill
United States Steel Co.
Gary, Ind.

EARLE B. STOUT
Senior Engineer in Forward Planning Division
Inland Steel Co.
South Chicago, Ind.

J. E. THOMPSON
Superintendent, Production Planning Department
United States Steel Co.
Gary, Ind.

LEON T. THOMSON
Process Engineer
United States Steel Co.
Vandergrift, Pa.

ROBERT H. TINDAL
Turn Foreman
Cold Mill Finishing
98 In. Strip Mill
Republic Steel Corp.
Cleveland, Ohio

FRANK TROTZ
Senior Draftsman
Atlas Steels, Ltd.
Welland, Ontario, Canada

HENRY E. WARREN, JR.
Assistant General Superintendent
United States Steel Co.
Morrisville (Bucks County), Pa.

ROBERT M. WEIKERT
Looper, Pipe Mills
Bethlehem Steel Co.
Sparrows Point, Md.

GERALD L. BOUSLOG
Engineering Draftsman
Republic Steel Corp.
Chicago, Ill.

AMBROSE J. CALLAGHAN
Senior Engineer Combustion Department
Bethlehem Steel Co.
Lackawanna, N. Y.

W. T. CLARK
Chief Engineer, Blast Furnaces
Republic Steel Corp.
Cleveland, Ohio

RUSSELL P. DISANO
Trainee Blast Furnace Department
Algoma Steel Corp., Ltd.
Sault Ste. Marie, Ontario, Canada

CHARLES F. B. DOVER
Electrical Engineer
Steel Co. of Canada, Ltd.
Hamilton, Ontario, Canada

OTIS B. ELDER
Civil Engineer
Allegheny Ludlum Steel Corp.
Brackenridge, Pa.

EDWARD W. ELDRETT
Mechanical Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

NICHOLAS A. FRAWLEY
Electrical Foreman
Atlas Steels, Limited
Welland, Ontario, Canada

SAMUEL GAMBINO, JR.
Expediter, Steel Division
Ford Motor Co.
Dearborn, Mich.

CLARENCE W. HARVEY
Roll Shop Foreman
Newport Steel Corp.
Newport, Ky.

ROBERT E. KARP
Chief Draftsman
Plant Engr., Steel Division
Ford Motor Co.
Dearborn, Mich.

HENRY C. KEISER
Assistant Chief Electrician
Blast Furnace Division
Great Lakes Steel Corp.
Ecorse, Detroit, Mich.

DAVID B. KETCHESON
Combustion Engineer
Ford Motor Co.
Dearborn, Mich.

KURT KIRCHNER
Assistant Engineer
Blast Furnace Department
Austrian Iron & Steel Works
Linz, Danube, Austria

PAUL A. KUNZ
Electrical Field Engineer
Maintenance Estimating Division
National Works
National Tube Co.
McKeesport, Pa.

H. W. MORGAN JR.
Fuel Engineer
A. M. Byers Co.
Ambridge, Pa.

ROBERT P. MORGAN
Assistant Superintenden Rolling Mills
Copperweld Steel Co.
Warren, Ohio

CHARLES E. MOYER
Assistant Superintendent
Open Hearth Department
Republic Steel Corp.
Buffalo, N. Y.

FRANK N. NOLAN
Superintendent Mechanical Department
Republic Steel Corp.
Buffalo, N. Y.

WILLIAM I. NORMAN
General Maintenance Foreman
Zanesville Division
Armco Steel Corp.
Zanesville, Ohio

HIROSHI OMOTO
Senior Managing Director
Toto Seiko, K. K.
Tokyo, Japan

TUNG SHENG PAO
Engineer in Charge
Shun Fung Ironworks, Ltd.
Kowloon, Hongkong

ARMAND PETERS
Superintendent Blast Furnace Department
HADIR Hauts Fourneaux et Acieries de Differdange
Differdange, Grand-Duche de Luxembourg

KHEMCHAND RAJKUMAR
Owner
Khemchand Rajkumar
Calcutta, West Bengal, India

S. E. RAUDEBAUGH
Roll Designer
American Steel & Wire Co.
Cleveland, Ohio

M. J. RICH
Plant Industrial Engineer
Fairless Works
United States Steel Co.
Morrisville, Pa.

NICHOLAS O. ROSS
Superintendent
Merchant Bar, Rod and Skelp Mills
Compania de Acero del Pacifico, S. A.
Talcahuano, Chile, South America

HIROSHI SAKAMOTO
Assistant Chief
Rolling Mill Department
Toto Seiko, K. K.
Tokyo, Japan

BARTON C. SALMON
Foreman Mechanical Department
Compania de Acero del Pacifico S. A.
Talcahuano, Chile, South America

ANTONIO JOSE D. DE OLIVEIRA SANTOS
Plant Superintendent
Cia Feddo E Aco De Vitoria S. A.
Vitoria, Espirito Santo, Brazil

J. J. SCHILLING
Design Engineer
United States Steel Co.
Pittsburgh, Pa.

Applications for AISE Membership

Associate

DONALD L. DeVRIES
Sales Engineer
Koppers Co., Inc.
Baltimore, Md.

WERNER DIETRICH
Contracting Engineer
Roberts & Schaefer Co.
Chicago, Ill.

SAM P. DIXON
Sales Engineer
Clisby Associates, Inc.
Birmingham, Ala.

HERBERT D. ERICKSON
Sales Manager
L. J. Land, Inc.
Reading, Pa.

ROBERT HANN, JR.
Salesman
R. B. Kraft Co.
Chicago, Ill.

MINOR CLYDE HAWK
Engineer
Affiliated Furnace, Inc.
Pittsburgh, Pa.

W. C. L. HEMEON
Engineering Director
Industrial Hygiene Foundation of America, Inc.
Pittsburgh, Pa.

JOSEPH M. HILL
District Manager
The Yoder Co.
Pittsburgh, Pa.

ARTHUR D. JOHNSON
Roll Designer
Sorel Industries, Ltd.
Sorel, Quebec, Canada

JOHN N. KERR
Vice-President
Grafo Colloids Corp.
Sharon, Pa.

LEIGHTON F. KORB
Contract and Associate Engineer
Freyn Engineering Department
Koppers Co.
Chicago, Ill.

EDWARD LAND
Electrical Engineer
L. S. Land, Inc.
Reading, Pa.

RICHARD C. LAWTON
District Engineer
Rolling Mills
The Torrington Co.
Philadelphia, Pa.

A. W. LUDLAM
Sales Engineer
Reliance Electric & Engr. (Canada) Ltd.
Montreal, Quebec, Canada

ADDISON MAUPIN
Development Engineer
The Chas. Taylor Sons Co.
Cincinnati, Ohio

LEO L. MEINERT
Chief Engineer
Affiliated Furnace, Inc.
Pittsburgh, Pa.

W. G. MOREHEAD
Salesman
Johns-Manville Sales Corp.
Chicago, Ill.

G. B. PAPEN
District Manager
Holmes Construction Co., Inc.
Melvindale, Mich.

ROBERT A PIPER
Electrical Engineer
Swindell-Dressler Corp.
Pittsburgh, Pa.

KENNETH D. REED
Manager
Mill Lubrication Department
De Laval Sales & Service, Inc.
Pittsburgh, Pa.

LOUIS J. REPASSY
Squad Supervisor
United Engineering & Foundry Co.
Pittsburgh, Pa.

W. S. RICHARDSON
Field Engineer
Electric Controller & Mfg. Co.
Pittsburgh, Pa.

HERMAN M. ROSS
District Manager
Graver Water Conditioning Co.
Chicago, Ill.

DONALD R. RYDER
Sales Representative
The Okonite Co.
Chicago, Ill.

PAUL L SAYRE
Engineer
Koppers Co. Inc.
Pittsburgh, Pa.

HOWARD E. SCHEIDLE
Field Engineer
Electric Controller & Mfg. Co.
Pittsburgh, Pa.

ALBERT J. SCHRAM
Control Engineer
Westinghouse Electric Corp.
Buffalo, N. Y.

JOSEPH A. SNOOK
Secretary
Atlas Mineral Products Co.
Mertztown, Pa.

ARTHUR L. THAYER
Application Engineer
Westinghouse Electric Corp.
Buffalo, N. Y.

EDWARD A. VITUNAC
Partner
Kerin & Vitunac Engineers
Pittsburgh, Pa.

RAYMOND E. WINTERS
Superintendent—Cleaning Department
Birdsboro Steel Foundry & Machine Co.
Birdsboro, Pa.

MICHAEL A. YALCH
Mechanical Designer and Checker
United Engineering & Foundry Co.
Pittsburgh, Pa.

FRANK W. ZURN
Manufacturers Representative
J. A. Zurn Mfg. Co. and Affiliate
American Flexible Coupling Co.
Erie, Pa.

J. G. H. BANKS
Engineer in Charge of Rolling Mill Applications
English Electric Co. of Canada
St. Catharines, Ontario, Canada

P. M. BARNES
Vice President
Eichleay Corp.
Pittsburgh 3, Pa.

JOSEPH A. BRANDT
Lubrication Engineer
Dow Chemical Co.
Madison, Ill.

CLARENCE A. DAYTON
Engineer
Eichleay Corp.
Pittsburgh 3, Pa.

C. W. DUFFETT
Field Engineer
Electric Controller & Mfg. Co
Pittsburgh 22, Pa.

RONALD W. DUNCAN
Application Engineer
The Louis Allis Co.
Milwaukee 7, Wis.

ROBERT B. EXNICIOS
Sales Engineer
Trumbull Department
General Electric Co.
Pittsburgh, Pa.

JACK R. FELDMAN
Sales Engineer
Silbo Steel Corp.
New York, N. Y.

D. R. GAILEY
Electrical Engineer
C. H. Hunt, Inc.
Pittsburgh, Pa.

HAROLD GASSNER
Vice President
Rosedale Foundry & Machine Co.
Pittsburgh, Pa.

W. J. GOOGE
Superintendent of Transmission
Southwestern Gas & Electric Co.
Shreveport, La.

P. T. HOPPER
District Sales Manager
SKF Industries, Inc.
Pittsburgh 19, Pa.

WILLIAM C. HUTTON
Engineer
Hutton & Hutton
Hammond, Ind.

MURRAY E. JOHNSON
Construction Manager
Eichleay Corp.
Pittsburgh, Pa.

E. L. KIRK
Assistant to Chief Engineer
Madison Division
Dow Chemical Co.
Madison, Ill.

RUDOLPH J. KNOLL
Rolling Mill Engineer
Dow Chemical Co.
Madison, Ill.

W. L. KOMPH
Manager of Sales & Engineering
Anker Holth Division
Wellman Engineering Co.
Port Huron, Mich.

JOHN F. KUNZ
Project Engineer
Eichleay Corp.
Pittsburgh, Pa.

BYRON D. MILLER
Steel Industry Relations Manager
Toledo Scale Co.
Toledo, Ohio.

ZARKO PAVLOVICH
Squad Leader in Engineering Department
Engineers and Constructors
Patterson-Emerson-Comstock, Inc.
Pittsburgh 22, Pa.

D. M. RICHARD
Electrical Engineer
International Construction Co., Ltd.
London, W. C. 2, England

HARRY G. SCHORR
Electrical Estimator
Triangle Electric Co.
Detroit 24, Mich.

WILLIAM E. SHORT
Engineer
Eichleay Corp.
Pittsburgh, Pa.

N. R. STODDARD
Project Engineer
Eichleay Corp.
Pittsburgh, Pa.

A. H. STROMEIER
Sales Engineer
Aetna-Standard Engineering Co.
Pittsburgh, Pa.

JOSEPH V. TRIPOLI
Treasurer
J. V. Tripoli & Co., Inc.
Buffalo, N. Y.

C. L. WELTY, JR.
Vice President
Eichleay Corp.
Pittsburgh, Pa.

STANLEY D. WHITESIDE
Chief Draftsman
Madison Division
Dow Chemical Co.
Madison, Ill.

WILLIAM M. ADLER
Eastern Sales Manager
National Alloy Steel Division
Blaw-Knox Co.
Philadelphia, Pa.

FRANK A. ALEXANDER JR.
Engineer Combustion Department
Rust Furnace Co.
Pittsburgh, Pa.

Junior

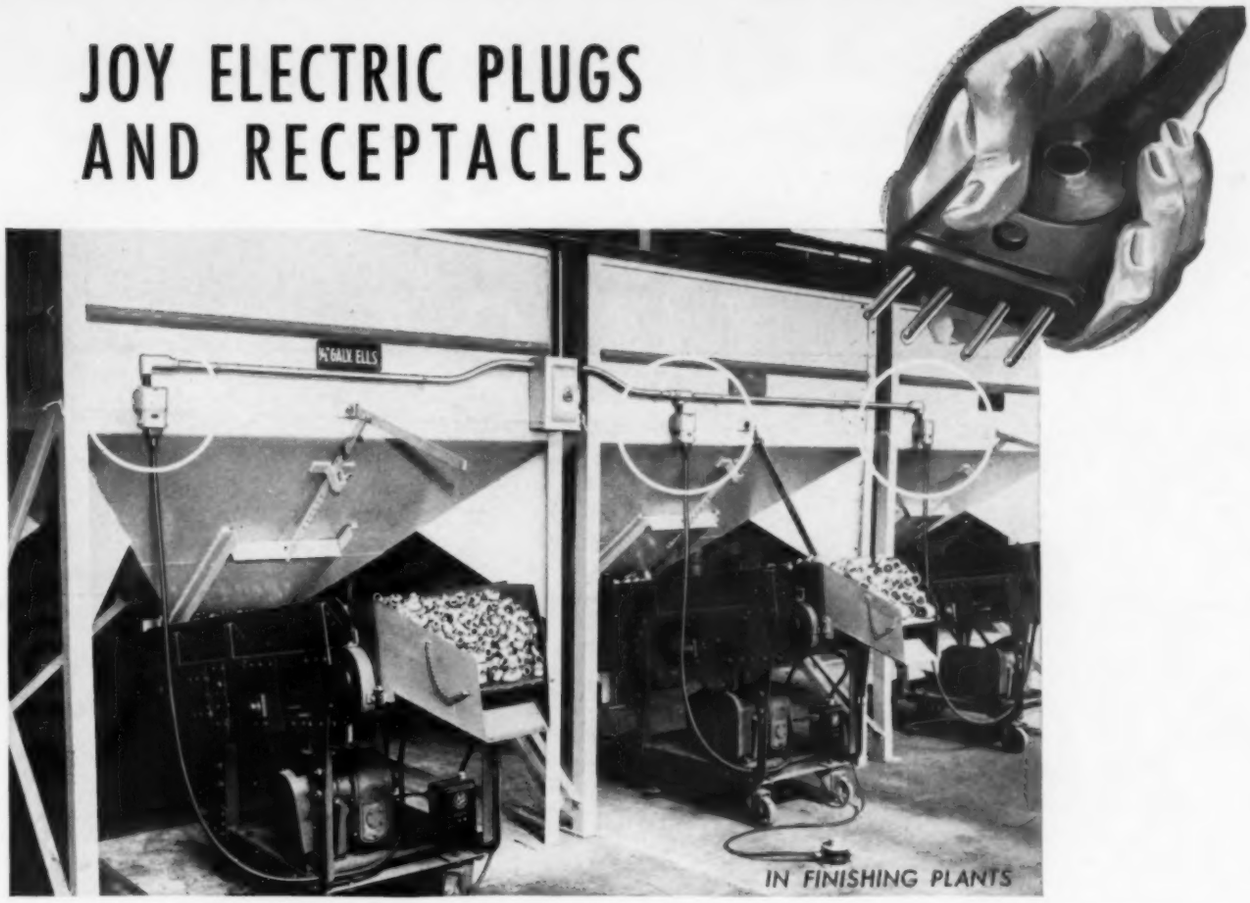
A. M. CAMERON, JR.
Combustion Engineer
Republic Steel Corp.
Buffalo, N. Y.

FRANK C. STANBROOK
Technical Engineer
Roll Shop
United States Steel Co.
Clairton, Pa.

ALVIN L. BINGHAM, JR.
Looper
Bethlehem Steel Co.
Lackawanna, N. Y.

DONALD R. CHRIST
Looper (Trainee)
Bethlehem Steel Co.
Sparrows Point, Md.

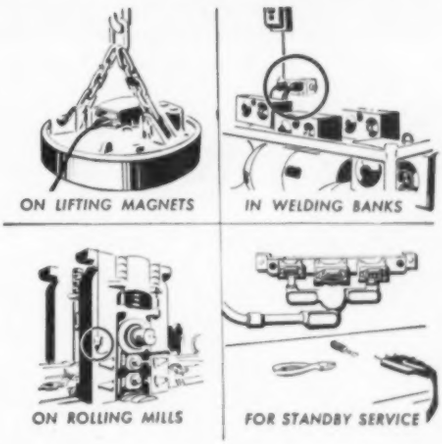
JOY ELECTRIC PLUGS AND RECEPTACLES



IN METAL PROCESSING PLANTS... STEEL MILLS ROLLING MILLS & FOUNDRIES

To earn the OK of Heavy Industry, electrical plugs and receptacles must function perfectly for long periods under conditions that quickly destroy many types now available for general industrial needs. That's our reason for believing the growing use of JOY connectors in metal processing plants, steel mills, rolling mills and foundries should be of particular interest to you. We're sure you'll want to know more about their inherent advantages (*see next paragraph*) before placing your next electrical connector order.

Factory molded to cable as one-piece Neoprene units, JOY connectors are little affected by rough handling, hard blows, grime, oil, moisture or vibration. Once installed, little or no maintenance is required. Available in designs and capacities to meet almost any portable power connecting requirement. Why risk electrical connector misfits when today's best actually costs less, in the long run. Full details including free literature available without obligation. Ask for them, today!



Consult a Joy Engineer

- ☆ *FACTORY MOLDED AS ONE-PIECE NEOPRENE UNITS*
- ☆ *SHATTER-PROOF, MOISTURE-TIGHT, WEAR-RESISTANT*
- ☆ *HIGHLY RESISTANT TO SUNLIGHT — OIL AND ACID*
- ☆ *EASILY INSTALLED — PROVIDE YEARS OF SERVICE*

... MORE THAN 100 YEARS OF ENGINEERING LEADERSHIP

M. E. 1151.1

JOY MANUFACTURING COMPANY

HENRY W. OLIVER BUILDING, PITTSBURGH 22, PENNSYLVANIA

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LTD., GALT, ONTARIO

Individual Motor Drive

350-TON, 6-MOTOR, 76′-0″ SPAN LADLE CRANE BRIDGE

BUILT BY MORGAN Engineering

Illustrated is a 350-ton, 4-girder, 24-wheel Ladle Crane bridge with six individual motor drives.

The six motors are carried on the individual trucks, each motor being coupled to a worm reduction unit on the drive axle. With this type of drive, the usual squaring shafts are eliminated.

On account of the moving mass to be controlled, which would require the usual hydraulic brake for each drive, an air braking system is provided.

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS

ELECTRIC TRAVELING CRANES • CHARGING MACHINES

INGOT STRIPPING MACHINES • SOAKING PIT CRANES

ELECTRIC WELDED FABRICATION • LADLE CRANES

STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES

SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

Equipment News...

STAINLESS SEAMLESS TUBE

▲ Seamless stainless steel tubing was produced on the new hot extrusion facilities of the Tubular Products Division of Babcock & Wilcox Co., Beaver Falls, Pa., for the first time in December. The announcement revealed that the B&W plant is the first in the United States, designed specifically to produce stainless steel tubing by the "Ugine-Sejournet" extrusion process, to be placed in actual operation.

It was pointed out that the process makes it possible for the first time to extrude hollow and solid sections of metals which forge with great difficulty. It also permits much finer and more complicated sections than heretofore possible even with the more readily forgeable steel alloys. Distinguishing feature of this extrusion method of producing seamless tubing is the use of glass to act for an extremely short time both as a lubricant for the hot worked metal and as an insulator to protect the die system.

Babcock & Wilcox first announced its intent to produce tubing by the "Ugine-Sejournet" extrusion process in mid-1950 upon the completion of a licensing agreement with Comptoir Industriel d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights.

OXYGEN GENERATOR

▲ Joy Manufacturing Co. recently announced the development of a semi-portable oxygen generator which will enable industrial users to produce their own high purity oxygen. This machine was developed in response to military needs in World War II, and has been perfected after nine years of research and development.

Joy will sell the new generator direct to industry, thereby opening broad new markets for the company in the steel, glass, metal fabrication, chemical and process industries.

The generator is a compact unit requiring space of 600 cu ft (8 by 7½ by 10 ft). Simplicity is its keynote and it has a minimum of moving parts. The Joy machine has no dependence on chemicals and nothing is consumed except air and power. Models are contemplated in the size range from 0.5 to 12 tons of high purity oxygen (99.5 per cent) daily capacity.

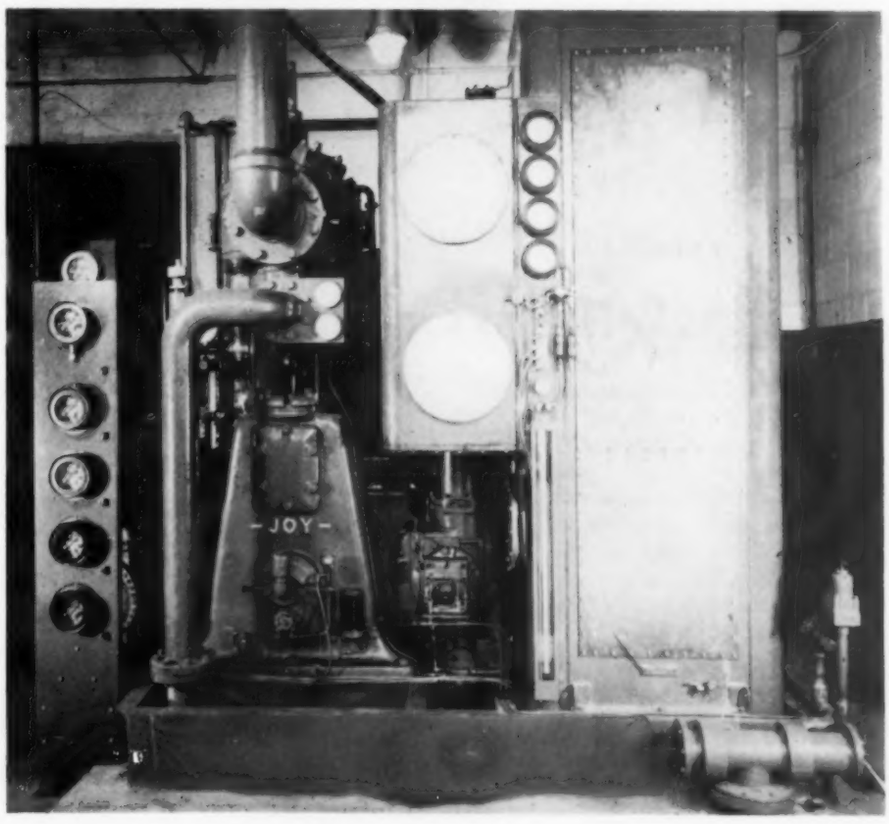
Despite the small size of the unit, it can produce high purity oxygen at an operating cost of $0.05 to $0.10 per 100 cu ft, depending on how much of the time it runs. This is equivalent to $12 to $24 per ton, and, as compared to the cost of purchased oxygen, represents savings to users of from 60 to 85 per cent before amortization. Savings to the consumer come mainly from eliminating oxygen transportation.

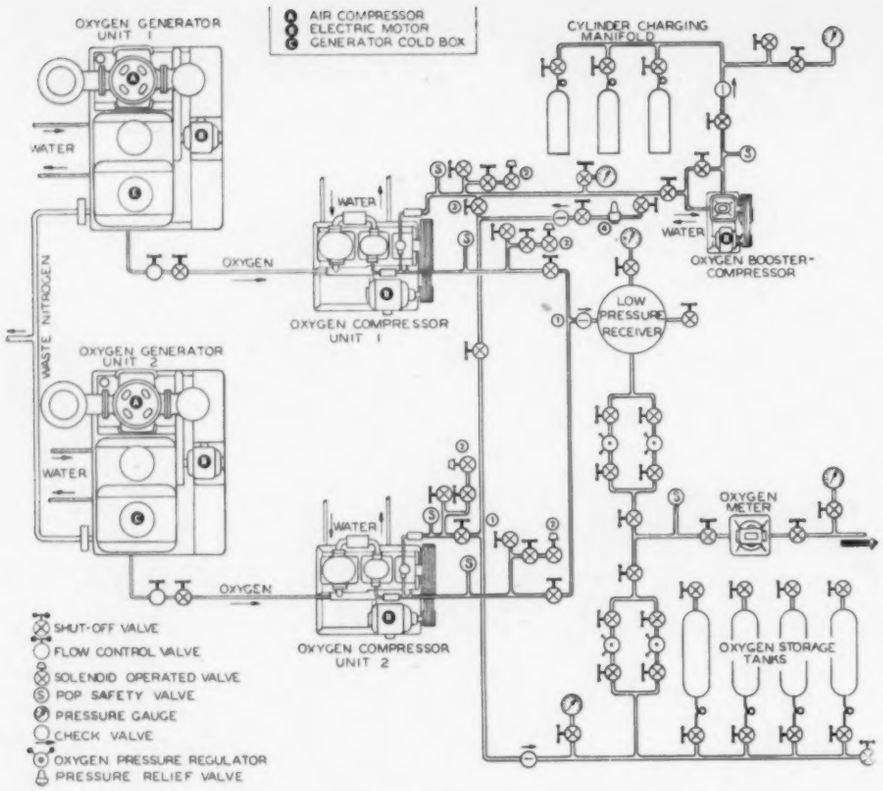
Heart of the Joy oxygen generator is a series of automatic reversing heat exchangers which eliminate the expense of chemical purification of the air. This heat exchanger tube is the key to the efficiency of the generator and the development of a method of making this ribbon packed heat exchanger tube is the secret of the unit.

In the operation of the unit, air after going through a two stage compressor is passed through twin heat exchangers at 160-180 psi. The air is chilled in the heat exchanger to –250 F, and the water and CO_2 are frozen. Flow is reversed every 2½ minutes. The O_2 and N_2 expand as they flow out the delivery ports, going through a filter into an expansion engine, driving a piston used in the unit cycle. This lowers the temperature to about –275 F. The air then goes through a third heat exchanger where it is chilled to the liquefaction point. This air then goes into a double column distillation unit where the pure oxygen is separated out in several steps. The generator is essentially a low pressure design and the highest pressure is about 180 psig. It takes about four hours to cool down from room temperature, but because of the insulation, only two hours are required to start the machine after a 24-hr shutdown. Units can be set up in single or multiple installations.

The Joy machine was designed

Development of this semi-portable oxygen generator will enable oxygen users to produce their own high purity oxygen.





The above diagram shows the layout of a typical installation of these oxygen generators.

specifically for generating high purity (99.5 per cent) oxygen. It is thus particularly applicable for steel plants, most of which use appreciable tonnages of oxygen for cutting, welding, scarfing and other uses. As it is presently designed it may not be economical for high tonnage oxygen users, since operating cost for units larger than the 12-ton unit would probably be the same as the operating cost of the smaller unit.

The half-ton capacity model will be offered in a price range of $20,000 to $35,000; the two-ton model, $35,000 to $45,000; the six-ton $85,000 to $100,000; and the 12-ton, $140,000 to $175,000.

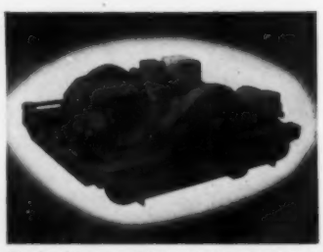
STRAIGHTENING PRESS

▲ Development of a highly versatile hydraulic straightening press featuring fast two-dimension positioning of the work is announced by E. W. Bliss Co. Quick positioning is obtained by hydraulic systems which move the press bed from side-to-side and the plunger assembly from front-to-back at the touch of a lever. It allows a number of blows to be struck at

HAVE *Strength* WHEREVER STRENGTH IS NEEDED

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

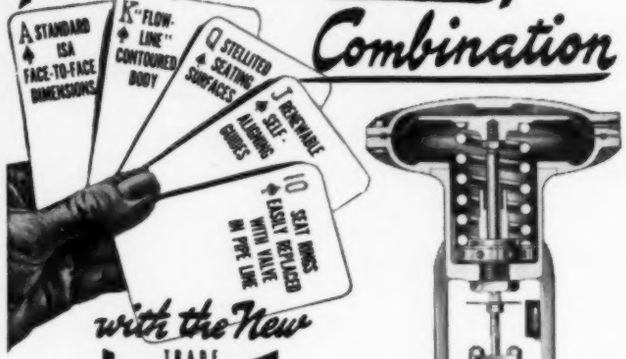
Ask for our Bulletin "E"



Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

You've got a Winning Combination

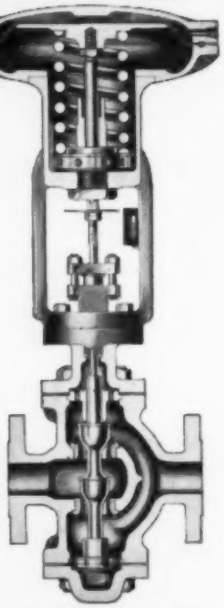

A STANDARD ISA FACE-TO-FACE DIMENSIONS
K "FLOW-LINE" CONTOURED BODY
Q STELLITED SEATING SURFACES
J REMOVABLE SELF-ALIGNING GUIDES
10 SEAT RINGS EASILY REPLACED WITH VALVE IN PIPE LINE

with the New

TRADE LESLIE MARK

DOUBLE SEATED DIAPHRAGM CONTROL VALVES

Calling a spade a spade you've got a "royal flush" of features in these new Valves designed for use with control instruments. With these Valves, you get as *standard equipment*, features heretofore only obtainable in expensive, specially designed valves.



Sectional view Class DV Double Seated Diaphragm Control Valve

ESTABLISHED 1909 LESLIE CO.

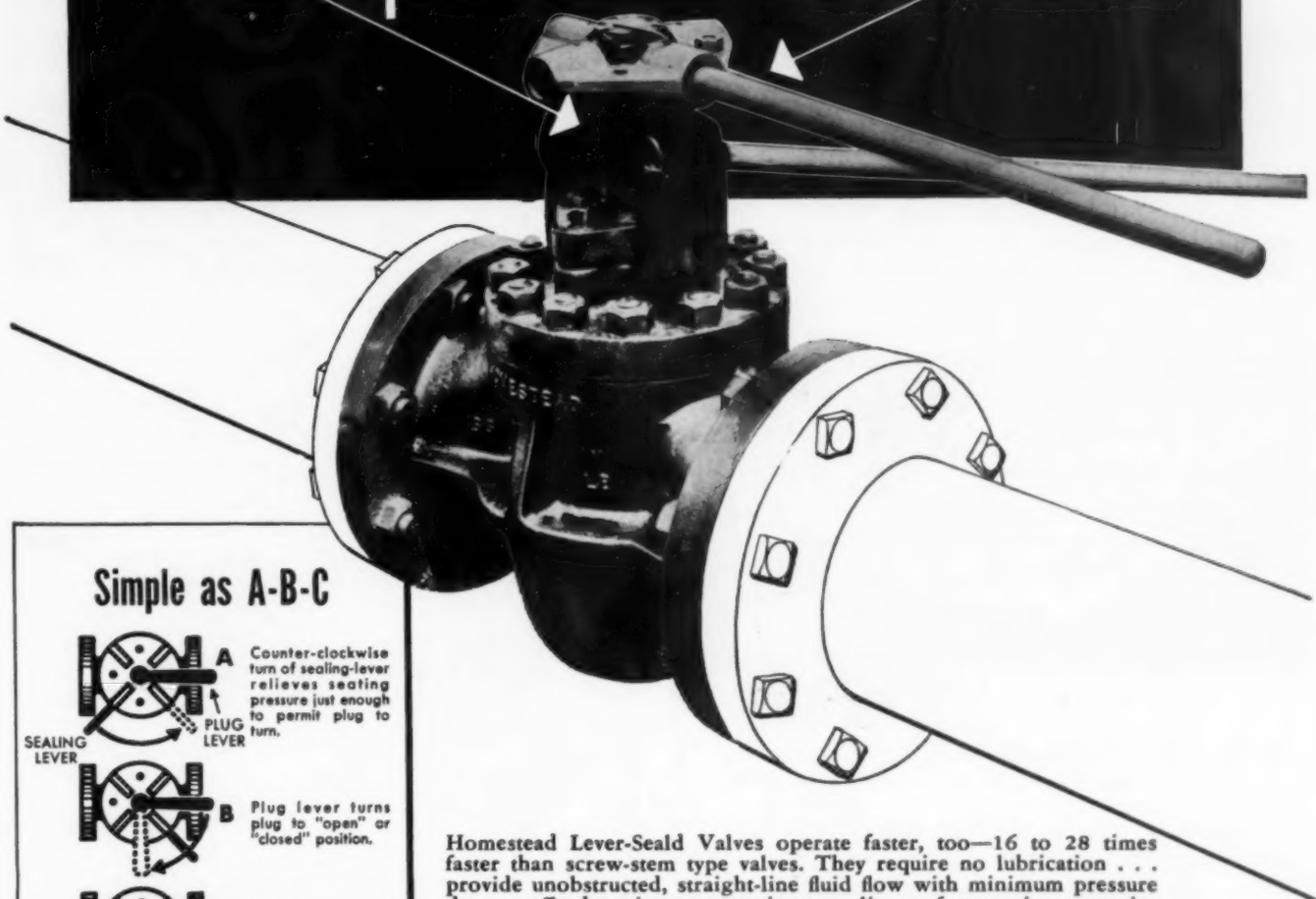
WRITE FOR Bulletin 513

1765 247 Grant Ave. • Lyndhurst, New Jersey

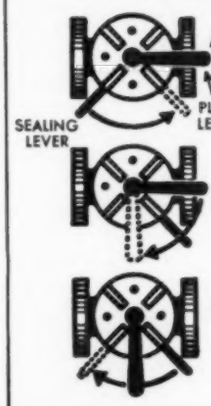
- at all times
- under all conditions
- throughout its long lifetime of service

This Homestead Valve will always work

it's **stickproof** because it's **lever-seald**



Simple as A-B-C



A Counter-clockwise turn of sealing-lever relieves seating pressure just enough to permit plug to turn.

B Plug lever turns plug to "open" or "closed" position.

C Clockwise turn of sealing-lever restores full seating pressure.

Homestead Lever-Seald Valves operate faster, too—16 to 28 times faster than screw-stem type valves. They require no lubrication . . . provide unobstructed, straight-line fluid flow with minimum pressure drop . . . afford maximum protection to sealing surfaces against corrosive and erosive line fluids. And because only a quarter-turn is needed for full opening or closing, they are ideal for installation in restricted areas where operation of other types of valves might be difficult.

Next time you have damaged or sticking valves, replace them with Homestead Lever-Seald Plug Valves. Once you use them you'll never be satisfied with ordinary valves.

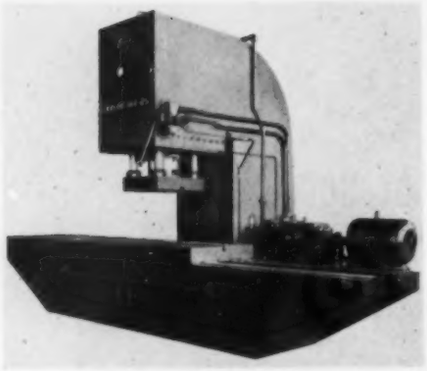
For complete information write for Valve Reference Book No. 39-3.

HOMESTEAD LEVER-SEALD PLUG VALVES

HOMESTEAD VALVE MANUFACTURING COMPANY

Serving since 1892

P.O. BOX 21 CORAOPOLIS, PA.



Quick positioning on this hydraulic straightening press is obtained by hydraulic systems which move the press bed from side-to-side and the plunger assembly from front-to-back at the touch of a lever. It allows a number of blows to be struck at different places on a single piece without changing the setting on the press table.

different places on a single piece without changing the setting on the press table.

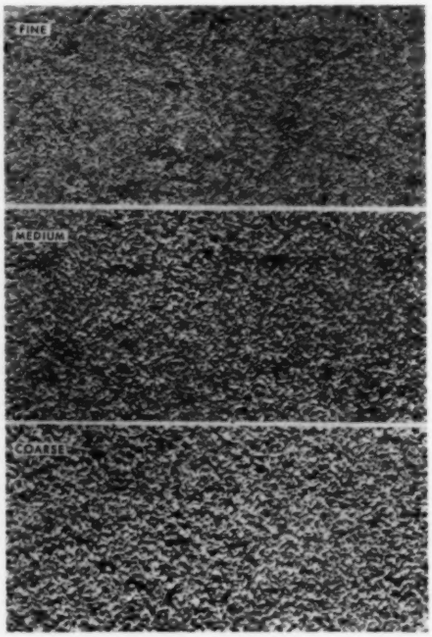
Speed of operation is further increased by a quick advance and return feature of the hydro-dynamic circuit which allows the slide to advance rapidly to the work and then slow up and do the actual straightening at slow speed, while returning to the "up" position rapidly.

Operation of the press is simple. Levers on the front of the bed control the front-to-back motion of the ram, the side-to-side motion of the bed, and the conventional up-and-down motion of the slide. Once the work is positioned under the ram, a fourth lever located on the front of the crown of the press locks it in position and transfers the output of the pump to the system controlling the up-and-down motion of the plunger.

The circuit, as applied to this 100-ton press, consists of a high-speed variable delivery rotary pump which controls the pressing speed and reversal without numerous controlling valves. Action is quicker and subject to less line friction.

GROUND CORNCOBS

▲ Manufacturers who use ground corn cobs for drying, buffing, tumbling or polishing will be interested in an announcement just made by Frank Miller & Sons. They have made arrangements for the entire ground corn cob output of a large mill which was constructed exclusively for this purpose. The new product, called "Cob-Dri," will be available in a choice of three popular grades; coarse, medium and fine, and will be fully dust free and graduated to exact uniformity. Orders for the new mate-



LET OAKITE SOLVENT DETERGENTS DO YOUR HEAVY CLEANING
DO YOU KNOW THEIR 9 BIG ADVANTAGES?
See page 7 ▶ ▶ ▶
FACTS about removing
OAKITE PRODUCTS, INC.

This new FREE booklet tells how two new types of Oakite-developed solvent detergents make it easier and cheaper for you to do many difficult metal-cleaning jobs. Here are some of the subjects covered in the booklet:

Cleaning metal between processing operations
Precleaning before painting or plating
Stripping paint
Providing temporary protection against rust
How to use Oakite solvent detergents:
Spray-washing machine method — **Spray-rinse method**
Soak-tank method — **Manual method**

FREE For a copy of this 24-page booklet (illustrated with photographs and diagrams), write Oakite Products, Inc., 19 Thames St., New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

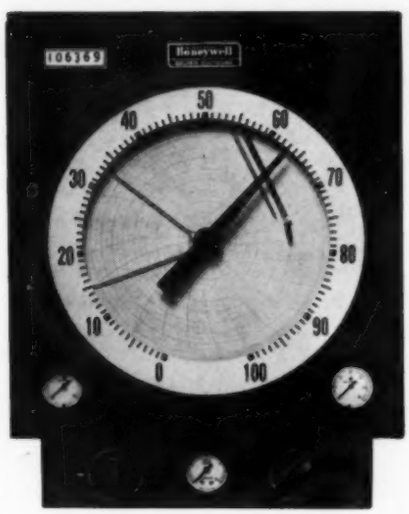
REVERE ELECTRIC MFG. CO.
6036 Broadway • Chicago 40, Ill.
INDOOR & OUTDOOR LIGHTING FOR EVERY NEED

New... Versatile...

records and controls all 3 variables

• 3-instrument control is applicable to any furnace. An *ElectroniK* Controller records furnace temperature, and resets an *ElectroniK* Fuel Flow Controller. This controller meters fuel, regulates the fuel valve, and in turn resets an Air Flow Controller. The latter records combustion air flow and throttles air in the desired proportion to fuel.

fuel-air ratio control



includes NEW *ElectroniK* Controller

An important feature of the system is the new *ElectroniK* Fuel Flow Controller. This instrument applies the industry-approved performance of the *ElectroniK* family to measurement and control of gas or oil flow. Linear scale and chart are easily read over the full instrument range. For fuel cost accounting, a built-in electronic integrator accurately totalizes fuel flow. Adjustable *Indexet* inside the instrument case provides easy setting of fuel-air ratio.

HIGHER EFFICIENCY of combustion, and closer control of atmosphere of industrial furnaces are now possible through Honeywell Fuel-Air Ratio Control. Outstandingly stable, this control interlocks temperature and ratio in a responsive pneumatic system. Air and fuel flow change in constant step with each other . . . follow heat demand quickly but without cycling.

Use of pneumatic control throughout assures accurate ratio at all firing rates. Ratio can be adjusted to any value from 0 to 200 percent, and can be biased to compensate for air infiltration or to change ratio at low flows. On dual fuel furnaces, a single switch transfers measurement and control from one fuel to the other.

Call in your local engineering representative for a discussion of your fuel-air ratio application . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Phila. 44, Pa.

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

● *Important Reference Data*

WRITE FOR INSTRUMENTATION DATA SHEET NO. 4.3-4A "METERED FUEL-AIR RATIO CONTROL"

rial will be accepted on any quantities from one bag to a carload.

WATER-HARDNESS TESTER

▲ Dr. Gerold Schwarzenbach, noted Swiss scientist, has been granted U. S. patents Nos. 2583890 and 2583891, which cover the new water-hardness tests that have gained widespread use in the past two years in this country.

Hagan Corp. and its affiliated companies, who are licensed under these patents, confirmed reports in industrial circles that official notice of the patents had been received.

Dr. Schwarzenbach, professor of chemistry at the University of Zurich and associated with the Swiss firm, Chemische Fabrik Uetikon in this development, is credited with revolutionizing the test procedures for water hardness. His method for total hardness determination has proved rapid, simple, and accurate within 1 part per million, compared with the century-old "soap-shaking" method which is slow, cumbersome and involves considerable subjective judgment.

A spokesman for Hagan stated that its affiliate, Hall Laboratories, Inc., engineering consultants on industrial water problems, had worked out modified procedures, reagents and equipment which make the basic Schwarzenbach methods convenient for field use.

The new methods are extremely accurate, easy and simple to follow, and very fast—require approximately one minute to complete. Step-by-step procedure is: (1) measured sample is poured into porcelain dish, (2) buffer solution is added, and the sample well mixed, (3) indicator is added, and well stirred, turning the water red, (4) titration turns the color from red to bluish at the endpoint.

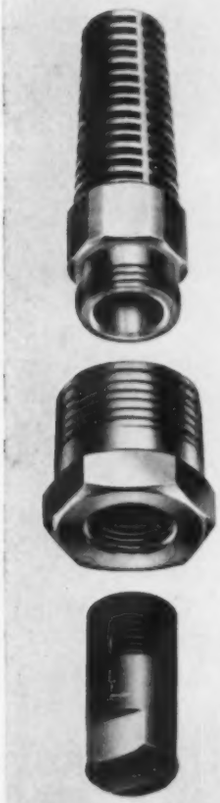
Both total hardness, and hardness due to calcium alone, can be quickly and precisely determined by the new test methods. Magnesium can be determined by difference. The method for total hardness is especially sensitive to small amounts; with no special precautions 1 ppm of hardness as $CaCO_3$ is detected, and with special techniques and more dilute titrating solutions even lower concentrations can be determined.

The endpoint of a test for total hardness is sharp and readily detected, so that the "human factor" which made the old soap-shaking method unreliable is practically eliminated in the new Schwarzenbach test.

There is no limitation on sample size, other than economy of operation, since no scum or salt effect can obscure the endpoint. Further, the new methods are widely applicable—to high or low hardness, in even fairly concentrated brines—and thus are gaining broad use in industry, public and private steam generating plants, marine applications and elsewhere.

TACONITE PROCESS

▲ An improved technique that makes it economically feasible to process



UNIFORM
descaling
with the Spraying Systems Descaling Nozzle

This hardened stainless steel nozzle provides a constantly uniform flat spray for clean descaling operations . . . all streaking is eliminated. Available in wide range of capacities.

LARGE DIAMETER ORIFICE

Note that the orifice is almost circular in shape . . . far less tendency to clog than the "old style" slotted orifice. Initial cost is lower. Maintenance cost is lower.

Write for complete information on this quality built nozzle and its large capacity strainer and adapter. Ask for Catalog 22 and Data Sheet 3997.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET
BELLWOOD, ILLINOIS
(Suburb of Chicago)

I Wish . . .

to enter one year's subscription for the IRON AND STEEL ENGINEER at $7.50 a year:

☐ Check enclosed
☐ Bill me later

I desire information on membership in the Association of Iron and Steel Engineers:

☐ Application blank
☐ Data

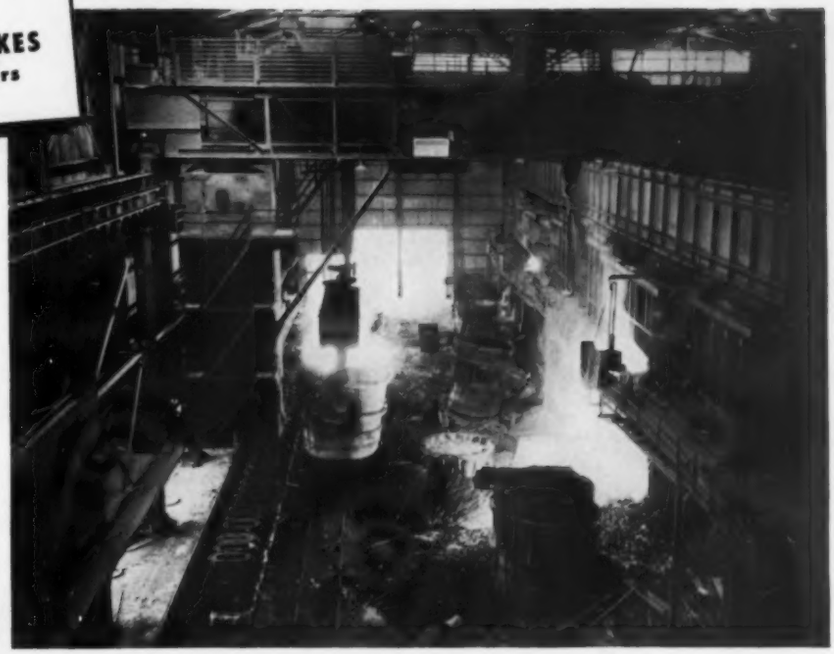
Name_____
Title_____
Company_____
Mailing Address_____

Mail this coupon to:

Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Penna.

Wagner
CRANE-BRIDGE BRAKES
...the choice of leaders in industry

be SURE your cranes are safe!



Equip them with Wagner CRANE-BRIDGE BRAKE SYSTEMS

You can be sure that your cranes are safe when they're equipped with Wagner *Hydraulic* Crane-Bridge Brakes. These brakes give your operators the same full control that you experience when you stop your automobile—They're simple . . . they're sure . . . they're safe.

The new Wagner Type HM-2 Bridge Brake System gives you an improved combination service and parking brake. A new snap-acting limit switch, mounted on the releasing cylinder, is mechanically tripped when the parking brake setting spring is completely compressed. Action is positive. The switch closes the electric circuit which energizes the magnetic-check-valve in the control unit and also illuminates a signal light in the crane cab indicating to the operator that the parking brake is released. The check valve traps the fluid under pressure in the releasing cylinder and holds the parking brake setting spring compressed as long as the check valve is energized. The parking brake is applied by merely pressing a button, and is automatically applied in the event of a power failure, or when the operator opens the main line switch to take the crane out of operation. At the same time, the signal light goes out indicating that the parking brake is applied.

Longer maintenance-free operation is assured by the use of materials that resist rust and corrosion in the releasing cylinder.

Only Wagner Hydraulic Braking Systems are equipped with the remote control bleeder that keeps the lines full of fluid and makes bleeding the system a simple "one-man one-minute" job, and only Wagner offers the self-centering device that prevents brake shoe drag by automatically assuring equal clearance of both shoes.

Other features include one-point shoe adjustment, 200% emergency torque, and non-scoring molded lining blocks that are easily replaceable.

If your cranes are not equipped with Wagner Brakes, we can show you how simple it is to install a modern hydraulic system. If you still have old-style Wagner Brakes, your system can be easily modernized with our complete conversion kits. Bulletin IU-40 gives full information—write for your copy.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

®Wagner Electric Corporation EST. WE 1891

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

IU-1

taconite—a hard stone containing 24 to 30 per cent iron—and also increases the value of low-grade iron ore has been announced by John R. Green, manager of the steel division of Minneapolis-Honeywell's Brown Instruments division. According to Mr. Green, the process is significant because the nation's deposits of high-grade ore as now known are expected to run out in 5 to 10 years, whereas there are "billions of tons" of taconite to draw upon.

The new technique consists primarily of finer temperature control and more exactness in maintaining fuel and air ratio and distribution in a taconite "pelletizing" furnace. Assuring the proper ratio of fuel and air in the processing of the ore causes it to be delivered with chemical and physical characteristics that equal those of higher grade ore. The method also makes possible maximum fuel economy.

In the improved process iron fines and dust of taconite are fused into pieces large enough to be easily transported and big enough to remain in the blast furnaces and not be blown away by the blast itself.

This application of instrumentation to the processing of taconite will facilitate reaching some long-range production targets for that source of iron. Some industry circles estimate production at as much as 15 million tons a year by 1956.

FAIRLESS MILL DRIVES

▲ The world's fastest cold strip steel mill drive, designed to operate a five-stand tandem mill at a top speed of 79½ mph is being built by the General Electric Co. for the Fairless works, Morrisville, Pa., of the United States Steel Co. This 21,650-hp drive is part of an order for G-E equipment for the giant new Pennsylvania plant.

With a planned capacity of 1,800,000 ingot tons of steel a year, the Fairless works will be the largest integrated steelmaking installation to be built in less than two years time.

Outstanding equipment for the vast plant will include not only the record-breaking cold strip mill drive, but also one of the world's fastest annealing lines (1000 fpm) and one of the largest annealing furnaces ever built—all supplied by General Electric.

The five-stand cold strip mill will roll tinplate material 30 inches wide up to 7000 fpm. It will employ six G-E drives ranging from 1400 to 6000 hp. Each drive will be supplied with separate generators. The final stand will be the first ever to be driven by a twin-drive unit utilizing six armatures.

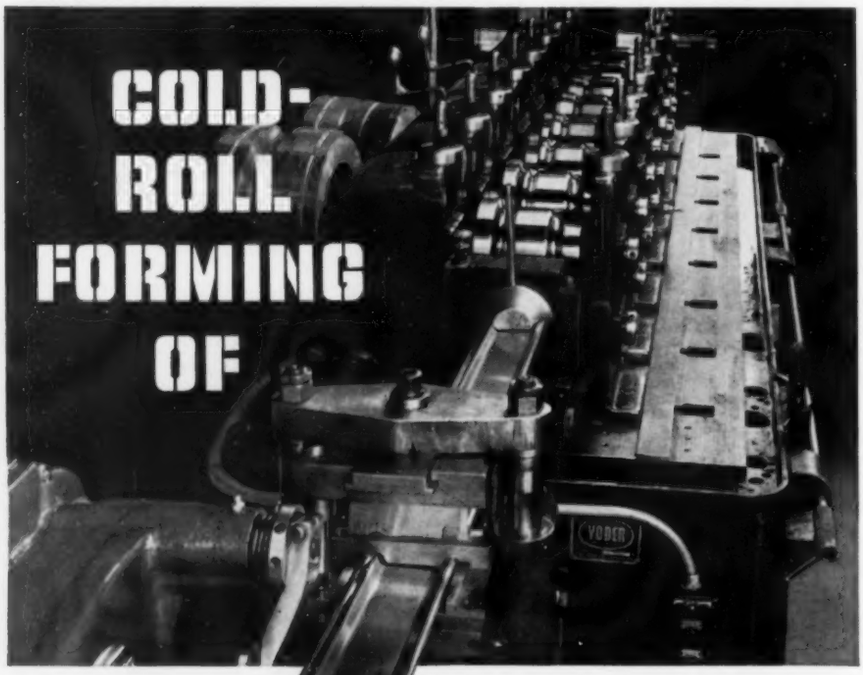
G-E will supply the furnace and complete motors and controls for the high-speed annealing line. The furnace, three stories high and 100 ft long, will have a record-smashing capacity of 30 tons an hour.

Use of amplidyne regulators for automatic control of tension, loop position and overspeeding will permit the 300-ft-long line to be operated by only a few men. The adjustable voltage system will serve more than 80 motors totaling 835 hp, and will be controlled by a panel 90 in. high and 92 ft long. A-c auxiliaries and the motor-generator set drive motors total more than 900 hp, requiring more than 100 lineal feet of group-assembled a-c motor control.

Also to be supplied by G-E is the electric equipment for the world's fastest 80-in., four-stand cold strip mill to operate at 3120 fpm. As in the five-stand mill, the main drive motors will total 21,650 hp, more than ever before utilized on a four-stand mill.

Purchased electric power for the plant will be supplemented with two 30,000 kw turbine generators, one of which is G-E equipment. All power will be used at 13,200, 2300 and 440 volts.

In addition, General Electric will furnish the electrical apparatus for the bar mill, as well as auxiliary motors and controls for the billet mill,



Pre-Coated Stock

When roll forming is not to be followed by other operations which may damage fine finishes, it is common practice to use stock which has already been given the finish ultimately desired. Because, with proper design, roll pressures can be held extremely low, and the further fact that the metal is not heated, the process permits a wide freedom of choice in decorative and protective finishes.

Large quantities of hot dipped galvanized stock are being cold-roll formed. Electro galvanizing and plating with chromium, brass and copper most easily meet roll-forming requirements. So also metal which has been polished, burnished, buffed or similarly treated.

Roll-forming of stock which has been painted or given other organic coatings, is also practical. Better coatings are constantly being developed for this purpose.

Thickness of stock, design of profiles, kind of coating desired, and number of roll passes, are the principal factors to be taken into account.

The services of Yoder engineers are at your disposal in finding the best answer to problems of this kind. Yoder Book on Cold-Roll-Forming is yours for the asking.

THE YODER COMPANY • 5497 Walworth Ave., Cleveland 2, Ohio

Complete Production Lines

- ★ COLD-ROLL-FORMING and auxiliary machinery
- ★ GANG SLITTING LINES for Coils and Sheets
- ★ PIPE and TUBE MILLS—cold forming and welding

ENGINEERING YODER MANUFACTURING

Roll More Tons per pass with PARALLOY

REGISTERED TRADE-MARK

The Quality Name in

PINCH ROLLS
COILER ROLLS
TENSION ROLLS
STEEL MILL ROLLS

No Scratching or Galling
500-600-BRINELL

Also Makers of

DUCTILE IRON

... A Recent and Revolutionary development in the casting industry.

Other Y&T Products

- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—TRAVELING AND LIFTING TABLES
- CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
- FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
- STRIP STEEL COILERS AND REELS—SCRAP BALLERS
- RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
- SHEET GALVANIZING LINES WIRE PATENTING FRAMES
- STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
- ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
- MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

hot strip mill and a 40 in. × 96 in. blooming mill.

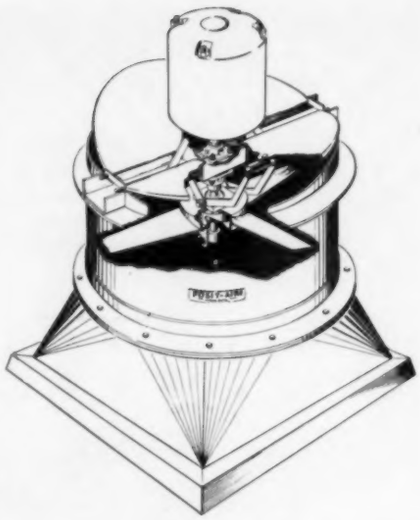
G-E equipment for the 10-in., 18-stand bar mill will include 18 motors ranging from 400 to 700 hp; three 2500-kw generators driven by a 10,500-hp synchronous motor; complete controls, and auxiliary motors.

G-E will supply all motors, controls, and motor-generator sets for the combination temper mill, side-trimming, slitting, recoiling and shearing line. This equipment will include 17 d-c motors ranging from 10 to 350 hp, 27 a-c motors, two 300-kw mg sets and a 500-kw mg set.

The Fairless works will have an annual capacity of 289,000 of cold-rolled sheets, 285,000 tons of bar products, 235,000 tons of hot-rolled sheets and 170,000 tons of tin mill products.

ROOF VENTILATOR

▲ Because of minimum restriction to impede air flow, this "Posit-Aire" roof type ventilator, manufactured by Tripar Products, Inc., moves maximum volume of air in range of 5000 to 45,000 cfm, depending upon size. The instant the fan is started, mechanically actuated louvers open fully and automatically. Power to open



louvers is provided by the fan drive motor through simple lever-clutch mechanism. Immediately when fan is stopped, louvers close positively and lock in closed position until unit is turned on again.

This automatic louver design prevents entrance of rain or snow, eliminates drafts or "stack effect" when unit is not operating and prevents back-draft or entrance of outside air. It offers reduction in fire hazard by eliminating draft through roof in event of a fire. Because louvers lock closed, burglar and sabotage protection is afforded.

Exhaust air discharges upward to protect roof from damage by fumes or moisture removed from plant. Engineered for field erection, unit can be supplied without motor or base for economy in shipping, storage and handling. Low silhouette affords attractive appearance on building. Standard sizes range from 24 to 48 inches. Special sizes, top or bottom motor mountings, or belt driven units for use in corrosive atmospheres can be furnished. Interiors and mechanism can be supplied with protective coatings for moisture and corrosion protection.

LOADER ATTACHMENT

▲ Designed to provide greater productivity, the sturdily built "Hykap" loader manufactured by Efficient Equipment, Inc. has proven extremely successful as a time and man saver in a long series of rigid tests conducted by the manufacturers.

The loader, which is adjustable to any size dump truck, consists of an attachable shovel or magnet, arms, and hydraulic equipment. Trucks equipped with this versatile unit

FROM STRIP
TO TUBES & SECTIONS
in your own mill

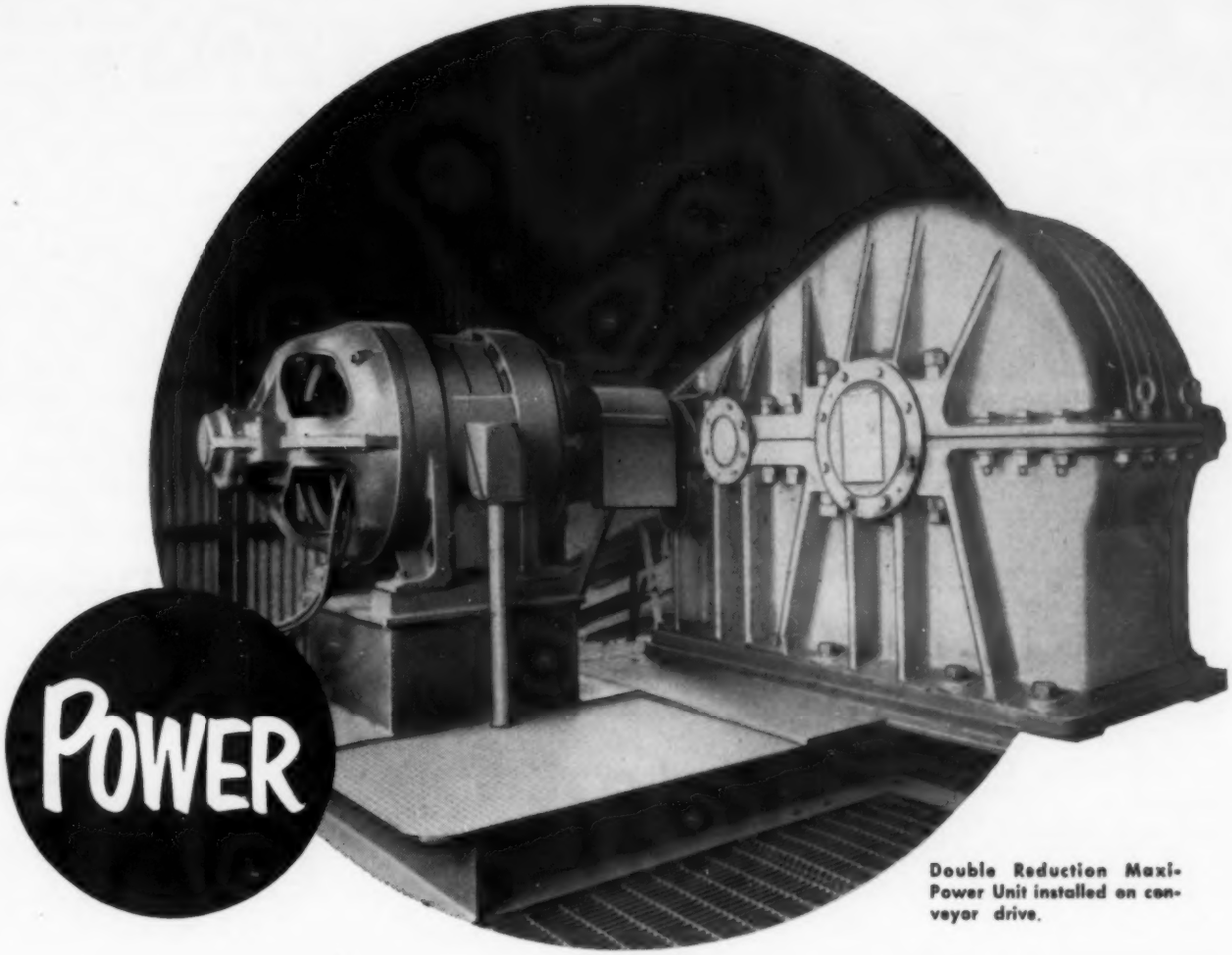
By installing Henderson Tube Making Machinery you can produce tubes and sections in any shape, in any diameter between ½" and 4½" and automatically cut-off to your exact requirements at speeds up to 130' per minute in your own plant.

HENDERSON MACHINES INCLUDE:—
ELECTRIC FUSION TUBE MILLS for steel tubes.
ATOMIC ARC TUBE MILLS for tubes in alloy steels such as stainless and chrome-molybdenum.
SECTION ROLLING MACHINES for cold rolled section in Ferrous or any other ductile material.
AIR HYDRAULIC PRESSES (4 ton) for tube manipulation.
2-SPINDLE DE-FRAZING MACHINES for the inside and outside ends of tubes.
TUBE BENDING MACHINES.

HENDERSON
TUBE MAKING MACHINERY

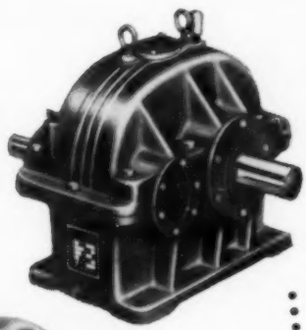
Illustration shows Henderson Electric Fusion Tube Mill which provides a continuous operation from the strip to the finished tube and all under the control of one operator. Electronic control of weld-heat is instant and stepless.

TUBE MAKING MACHINES LIMITED
BLAENRHONDDA, GLAMORGAN, WALES. Telephone: Treherbert 292/3. Telegrams: Tubemac, Treorchy.

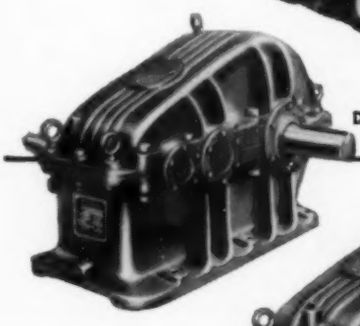


Double Reduction Maxi-Power Unit installed on conveyor drive.

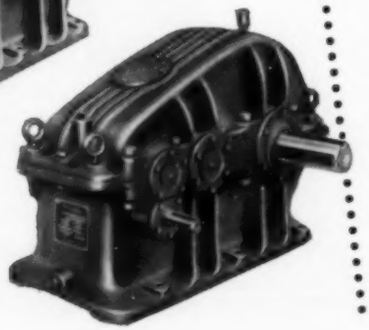
in minimum space with *Maxi-Power* parallel shaft drives



SINGLE REDUCTION



DOUBLE REDUCTION



TRIPLE REDUCTION

For heavy-duty applications, here is a drive that offers the maximum in sturdy, reliable service.

Precision generated helical gearing with uniform load distribution across the entire face means improved performance — permits maximum load-carrying capacity in minimum space.

Maxi-Power Drives are available in single, double and triple reductions in ratios from 2.08 to 1 up to 360 to 1 — capacities up to 1,550 h.p.

Mail the coupon for engineering bulletin on Maxi-Power Drives or call the Foote Bros. Representative near you.

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. IAS, 4545 S. Western Blvd. • Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 S. Western Blvd., Chicago 9, Ill.

Please send Bulletin MPB containing full information on Maxi-Power Drives.

Name.....

Company.....

Position.....

Address.....

City..... *State*.....

The loader with a 29-in. magnet, operated by a 5 kw generator, about to release lift of scrap iron into the truck body.

automatically become multi-purpose, all season machines since the loader can be used as a hydraulic lift platform for loading drums, bales, crates, or shop-box containers with maximum speed and minimum effort. It also can be utilized as a light crane for lifting materials into other trucks, bins, and low gondola freight cars.

Simple to operate, the loader transforms a standard dump truck into an all-purpose unit that can do the work of several machines.

The loader is mounted on the rear of the truck body and is operated by controls on the top of the truck cab or from auxiliary controls on the side of the truck. Once the loader is installed it is a simple process to put it into operation. By engaging a fork attached to the truck transmission and by slipping a four-fingered attachment over the steering wheel, the loader is made ready for operation. In this manner, the driving apparatus on the top of the cab is attached and detached in a matter of a few seconds. The hydraulic arms of the loader work directly off the power takeoff of the vehicle itself.

A complete set of controls including clutch, gas pedal, steering wheel, and gear shift is located on the top of the cab. Two levers, one to open and shut the shovel, and the other to operate the hydraulic cylinders that raise and lower the arms are also located on the top of the cab. From his seat on top of the cab, the driver of the truck can operate the loader, and drive his vehicle in any direction without having to climb down from his perch.

Another outstanding feature of the loader is the attachable allied combinations that make the loader adaptable to many jobs. First is the shovel or bucket, that can shovel a cubic yard of loose material at a time. This shovel, under tests, has loaded over one ton per minute and has lifted as much as 4400 lb at a time.

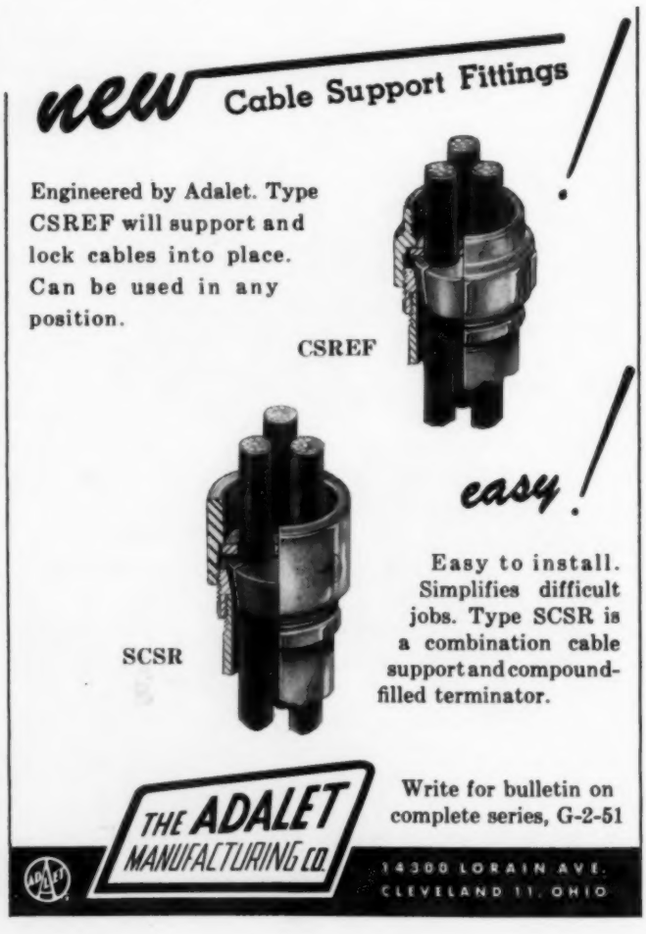
A 29-in. magnet, operated by a 5 kw generator, is the second attachable piece. This is primarily for picking up loose scrap iron and is operated much in the same manner as the shovel. The operator of the loader simply lowers the magnet into a pile of scrap, the magnet attracts the material, then the loader is raised and the load of scrap is released into the truck all within a few seconds.

AID DEFENSE

More Scrap Today . . .

More Steel Tomorrow . . .

Non-ferrous Scrap Is Needed Too!


new Cable Support Fittings
Engineered by Adalet. Type CSREF will support and lock cables into place. Can be used in any position.
CSREF
SCSR
easy!
Easy to install. Simplifies difficult jobs. Type SCSR is a combination cable support and compound-filled terminator.
THE ADALET MANUFACTURING CO.
Write for bulletin on complete series, G-2-51
14300 LORAIN AVE.
CLEVELAND 11, OHIO

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
Worm Gearing and Worm Gear Speed Reducers
THE FARVAL CORPORATION
Farval Centralized Lube Systems
LUBRICATION PRODUCTS COMPANY
Stapax Journal Box Lubricators
AMERICAN FLEXIBLE COUPLING COMPANY
Amerigear Flexible Couplings
WALDES KOHINOOR, INCORPORATED
Truarc Retaining Rings

CLEVELAND DISTRICT

REDUCE SHUTDOWNS . . .
with HEIL Lined Tanks and Piping.
HEIL PROCESS EQUIPMENT CORP.
12901 Elmwood Ave.
CLEVELAND 11, OHIO

PHILADELPHIA DISTRICT

TOWLE & Son Co.
18 West Chelton Ave. GE 8-1930
PHILADELPHIA 44
Representing:
THE TOOL STEEL GEAR AND PINION CO.
Cincinnati 16, Ohio

MOFFATT BEARINGS COMPANY
1640 Fairmount Avenue
PHILADELPHIA 30, PA.
Phone: POplar 5-3443
A Complete Anti-Friction Bearing Service
Ball, Roller, Thrust and Needle

PITTSBURGH DISTRICT

ROLLING MILLS *and* EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA.
Cable Address "FOSTER" Pittsburgh

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building PITTSBURGH, PA.
COurt 1-7032

PATTERSON-EMERSON-COMSTOCK, INC.
ENGINEERS AND CONSTRUCTORS
Specializing in Steel Mill Construction
313 E. Carson Street
Pittsburgh 19, Pa.
Phone: EVerglade 1-9800

Auburn & Associates, Inc.
Engineers
ELECTRICAL LAYOUTS FOR STEEL MILLS
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

CHEMSTEEL CONSTRUCTION COMPANY, INC.
204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
Send data on Engineering & Construction facilities for
ACID-ALKALI-PROOF CONSTRUCTION
of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

PITTSBURGH (Continued)

W. G. KERR CO., INC.
520 Oliver Building PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
SMITH—Telesmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

RITTER ENGINEERING CO.
Engineers - Distributors - Contractors
3031 WEST LIBERTY AVE. Phone:
PITTSBURGH 16, PA. LOCUST 1-1303
Representing:
TRABON ENGINEERING CORP.
"Centralized Lubricating Systems"

BLAST FURNACES
Industrial Furnaces & Boilers
• Construction • Rebuilds • Linings
• Maintenance • Repair
AFFILIATED FURNACE, INC.
204 Chemsteel Building, Walnut Street, Pittsburgh 32, Pa.

PRODUCTS

Engineered-Rebuilt Machine Tools
Engineered-Rebuilding of Your Machine Tools
SIMMONS MACHINE TOOL CORP.
Main Office and Plant:
Albany 1, New York
Pittsburgh Representative:
3541 Laketon Road PEnhurst 1-3700

CONSULTING ENGINEERS

LOYAL R. MILBURN
Consulting Electrical Engineer
Registered State of Michigan
1928 Guardian Building • Detroit 26, Michigan
Telephone: Woodward 3-8706 or
Whitmore Lake 5141

THE ENGINEERING MART

(CONTINUED)

Consulting Engineers (Continued)

PAUL J. DOYLE
Research Consultant
offers
"EXPERIENCED"
Consulting Service
on
INDUSTRIAL WASTE CONTROL
oils — acids — alkalis
PICKLE LIQUOR DISPOSAL
FOR THE STEEL INDUSTRY
Inquire:
INDUSTRIAL WASTE CONTROL
2041 Revely Avenue Lakewood 7, Ohio
Phone: AC-1-1957

WILLIAM N. HORKO
Industrial Engineer
Design and layout of
industrial heating and treatment equipment.
1015 Cherry Street Philadelphia 7, Pa.
LOmbard 3-8773

POSITIONS WANTED

DESIGN ENGINEER
10 to 15 years practical experience in designing Open-Hearth Furnaces. Write giving details to Employment Office.
BETHLEHEM STEEL CO.
501 E. Third St. BETHLEHEM, PA.

WANTED
SALES ENGINEER — with steel mill operating experience — mechanical background, for outside sales, service and engineering. Products include gears, rolls, wheels, etc. to Maintenance Departments of steel mills Eastern Pennsylvania. Finest quality product. Give complete resume and photo. Replies confidential. Reply Box No. 300 IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

Use
The
Engineering
Mart

•

DISPLAY RATES:
$8.00 PER COLUMN INCH.

•

Send Your Copy To:
IRON and STEEL ENGINEER
1010 Empire Building
Pittsburgh 22, Pa.

Yes, Lockheed in California can train you – at full pay!

The step up to Aircraft Engineering isn't as steep as you might expect.

Aircraft Experience isn't necessary. Lockheed takes your knowledge of engineering principles, your experience in other engineering fields, your aptitude, and adapts them to aircraft work. You learn to work with closer tolerances, you become more weight conscious.

What's more, Lockheed trains you *at full pay*. You learn by doing – in Lockheed's on-the-job training program. When necessary, you attend Lockheed classes. It depends on your background and the job you are assigned. But, always, you learn at full pay.

These opportunities for engineers *in all fields* have been created by Lockheed's long-range production program – building planes for defense, planes for the world's airlines.

And remember this: When you join Lockheed, your way of life improves as well as your work.

Living conditions are better in Southern California. The climate is beyond compare: Golf, fishing, motoring, patio life at home can be yours the year 'round. And your high Lockheed salary enables you to enjoy life to the full.

Note to Men with Families: Housing conditions are excellent in the Los Angeles area. More than 35,000 rental units are available. Thousands of homes for ownership have been built since World War II. Huge tracts are under construction near Lockheed.

Send today for illustrated brochure describing life and work at Lockheed in Southern California. Use handy coupon at right.

ENGINEER TRAINING PROGRAM
Mr. M. V. Mattson, Employment Mgr.
Dept. ISE-3

LOCKHEED
Aircraft Corporation
Burbank, California

Dear Sir:

Please send me your brochure describing life and work at Lockheed.

My Name

My Field of Engineering

My Street Address

My City and State

steel mill combustion control problems

are solved with

HAGAN

Air-Operated Controls

and Ring Balance Meters

Hagan Air-Operated Controls assure accurate and dependable combustion control in steel mill operations. Hagan Metering Equipment can also be relied upon to provide dependable service in steel mill applications. Such typical applications include:

- **Heat Input Control**
- **Fuel-Air Ratio Control**
- **Furnace Pressure Control**
- **Gas Pressure Control**
- **Gas Mixing Station Control**
- **Flow Meters for gas, steam, water, and compressed air**
- **Control of multiple fuel firing**
- **Reversal Control**
- **Draft and Pressure Recorders**
- **Btu Meters for mixed fuels**

Our engineers will be glad to help you solve your combustion control problems. For full information, write to:

HAGAN CORPORATION

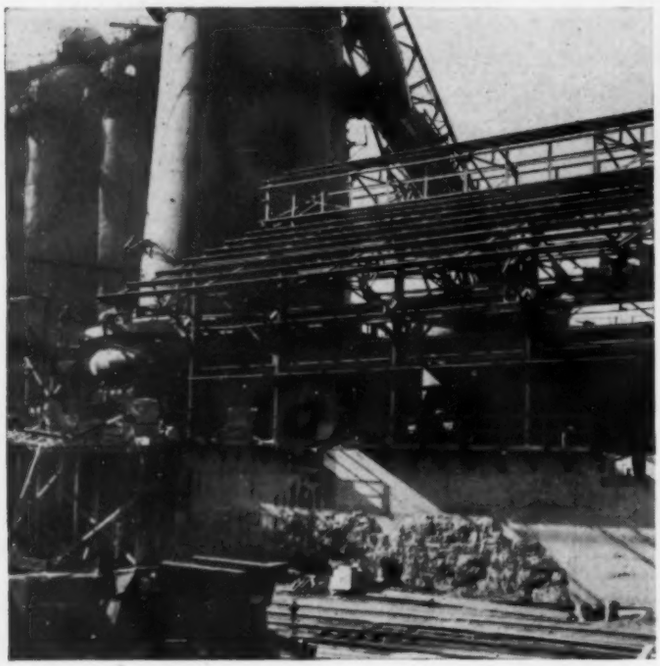
HAGAN BUILDING, PITTSBURGH 30, PA.

METALLURGICAL FURNACE CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
BOILER COMBUSTION CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

DEMOLITION

FOUNDATION

ERECTION

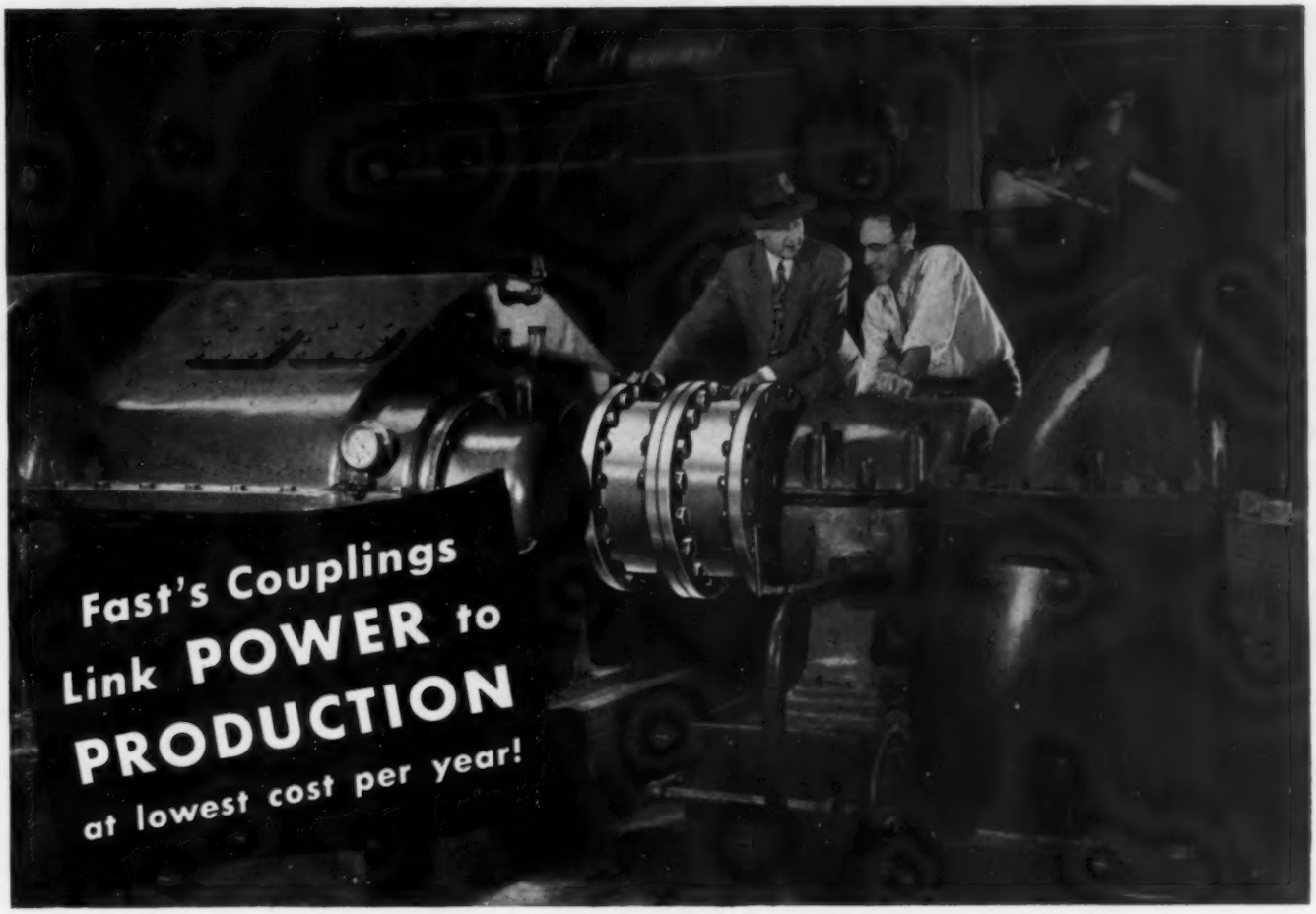


LINING

Affiliated Furnace does the **WHOLE JOB!**

AFFILIATED FURNACE, INC. 5428 Walnut St., Pittsburgh 32, Pa.

BLAST FURNACE CONSTRUCTION • REBUILDS • LINING • REPAIR



Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 213 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS

FAST'S®
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
213 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

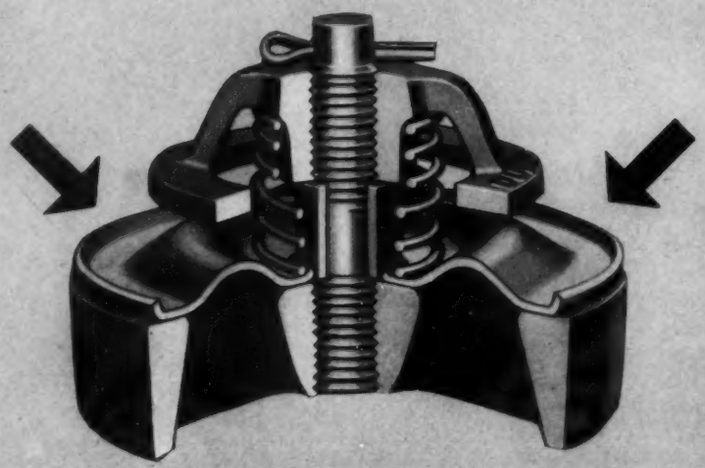
Company .....

Address .....

City ..... *Zone* ..... *State* .....

DURABLA

Valve Member Utilizes Arch Construction For Strength But Can Flex To Adjust To Any Slight Variations In Plane Of Valve Seats.



Valve Member Is Free To Move Around The Guard-Stem Or To Assume Any Angle And Maintains A Seal Which Is Self-Grinding At All Times

PUMP VALVE SERVICE

The patented arch construction Durabla Valve Member* retains sufficient flexibility, despite its great strength, so that the valve-to-seat contact maintains a constant pressure-proof seal. The Valve Seat is rigid, the Valve Member is freely mounted. Hence the free member accommodates itself to wear of the valve parts which may occur in severe service.

Since the Valve Member is freely mounted, a unique feature of Durabla engineering, it can turn about the Guard-Stem and a self-grinding pressure-proof seal is always maintained. Lower maintenance costs; Infrequent need for inspection; Minimum lost time for repairs are all achieved through the use of Durabla "The Valve That Grinds Itself."

Address DURABLA Engineering Department for Information and Bulletin No. 253

* Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

INDEX TO ADVERTISERS

MARCH, 1952

A

Adalet Manufacturing Co., The 194
Aetna-Standard Engineering Co., The 1
Affiliated Furnace, Inc. 198
Aldrich Pump Co. 144
Alliance Machine Co., The 31
American Brakeblok Division, American Brake Shoe Co. 154
American Chemical Paint Co. 146
American Manganese Steel Co. Division, American Brake Shoe Co. 13

B

Bailey Meter Co. 202
Bantam Bearings Division of The Torrington Co. 36
Birdsboro Steel Foundry and Machine Co. 33
Bliss Co., E. W. 28, 29
Bloom Engineering Co. 174
Bonnot Co., The 159
Bristol Co. 44, 45
Brooks Oil Co. 127
Browning and Co., Inc., Victor R. 184
Bussmann Manufacturing Co. 124, 125

C

Cities Service Oil Co. 27
Clark Controller Co. 132
Cleveland Crane and Engineering Co. 48
Continental Foundry and Machine Co. 7
Crane Co. 50
Crouse-Hinds Co. 46, 47
Cutler-Hammer, Inc. ..... Cover 2

D

Documentation & Licenses, Paris, France 52
Dravo Corp. 164
Drever Co. 147
Durabla Manufacturing Co. 200

E

Electric Controller and Manufacturing Co. 6, 145
Electric Products Co., The 168
Electric Service Manufacturing Co. 163
Elliott Co. 149, 165

F

Falcon Bronze Co. 168
Farrel-Birmingham Co., Inc. 151
Farrell-Cheek Steel Co. 26
Farval Corp. ..... Cover 3
Flinn & Dreffein Engineering Co. 52
Foote Brothers Gear and Machine Corp. 193
Foxboro Co. 167
Furnace Engineers, Inc. 24, 25

G

General Electric Co. ..... 16, 17, Cover 4
General Refractories Co. 42, 43
Gould-National Batteries, Inc. 18
Gulf Oil Corp. 2

H

Hagan Co., George J. 39
Hagan Corp. 197
Hallden Machine Co., The 52
Harbison-Walker Refractories Co. 14, 15
Heppenstall Co. 123
Homestead Valve Manufacturing Co., Inc. 185
Hyde Park Foundry and Machine Co. 194
Hydropress, Inc. 3

I

Ideal Industries, Inc. 152
Iron and Steel Exposition 138
Ironsides Co., The 51

J

Joy Manufacturing Co. 181

K

Kaiser Aluminum & Chemical Sales, Inc., Chemical Division 140
Koppers Co., Inc. 156, 157, 199

L

Leeds and Northrup Co. 12
Leslie Co. 184
Lewis Foundry and Machine Division, Blaw-Knox Co. 10, 137
Linde Air Products Co., A Division of Union Carbide and Carbon Corp. 30
Link-Belt Co. 22
Lintern Corp. 162

M

Manning, Maxwell and Moore, Inc., Shaw-Box Crane and Hoist Division 158
Marvel Engineering Co. 172
Mesta Machine Co. 5
John Miles & Partner (London, Ltd.) 52
Minneapolis-Honeywell Regulator Co., (Industrial Division) 187
Morgan Construction Co. 21
Morgan Engineering Co. 182

N

Nagle Pumps, Inc. 153
National Carbon Co., A Division of Union Carbide and Carbon Corp. 160, 173
National Electric Coil Co. 32

O

Oakite Products, Inc. 186
Okonite Co., The 129

P

Pacific Pumps, Inc. 4
Pennsylvania Engineering Corp. LS-15
Pennsylvania Transformer Co. 169
Pittsburgh Lectromelt Furnace Corp. 54
Pollock Co., William B. LS-14
Poole Foundry and Machine Co. 20
Post-Glover Electric Co. 38

R

Revere Electric Manufacturing Co. 186
Ross Carrier Co., The 150
Rust Furnace Co. 121
Rust-Oleum Corp. 133

S

Salem-Brosius, Inc. 37
Spraying Systems Co. 188
Square D Co. 171
Surface Combustion Corp. 40, 41

T

Taylor Chain Co., S. G. 148
Timken Roller Bearing Co., The ..... Cover 1
Trabon Engineering Corp. 134
Treadwell Construction Co. LS-16
Truflo Fan Co. 155
Tube Making Machines, Ltd. 192

U

Union Carbide and Carbon Corp., Linde Air Products Co. 30
Union Carbide and Carbon Corp., National Carbon Co. 160, 173
Union Steel Castings Division Blaw-Knox Co. 142
United Engineering and Foundry Co. 19
United States Graphite Co. 141

V

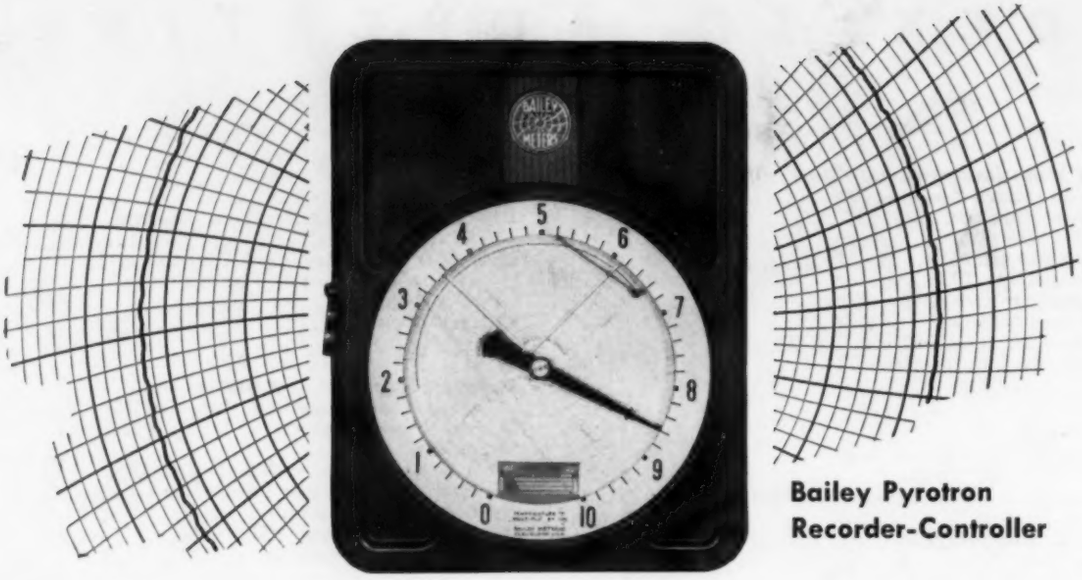
Vaughn Machinery Co. 139

W

Wagner Electric Corp. 189
Wean Engineering Co., Inc., The 52
Wean Engineering Co. of Canada, Limited, The 52
Wean Equipment Corp. 52
Wellman Engineering Co., The 8
Westinghouse Electric Corp. 9, 23, 34, 35
Wilson Engineering Co., Inc., Lee 11

Y

Yoder Co., The 190
Youngstown Alloy Casting Corp. 131
Youngstown Foundry and Machine Co. 191



Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

. . . Then check these features of Pyrotron Electronic Resistance Thermometers . . .

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

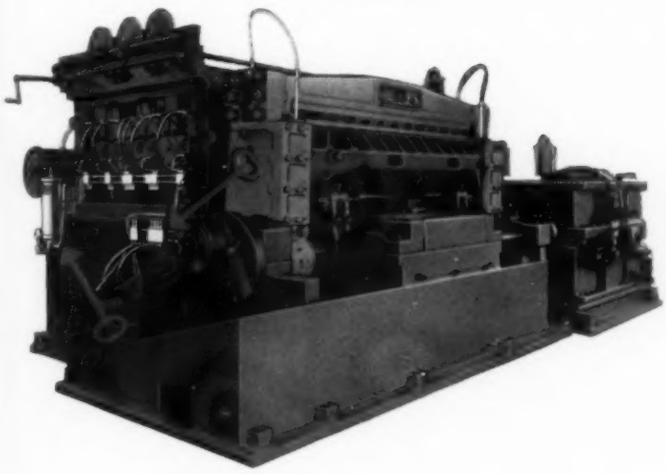
1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

Farval solves the lubrication problem on Automatic Shears

FARVAL—*Studies in Centralized Lubrication* No. 128



KEYS TO ADEQUATE LUBRICATION— *Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.*

Photo by courtesy The Hallden Machine Company.

AUTOMATIC flattening and cutting machines in steel mill service get rough treatment. There are always scale and dirt in the air. To keep dirt out of bearings, enough oil is used to insure its working out of the bearing ends. In most mills, machines are worked round the clock, so there is no time to lubricate without shutting down. Continued use without proper oiling guarantees trouble.

To insure adequate, continuous lubrication, The Hallden Machine Company depends on Farval Centralized Lubrication. In fact, it has been standard practice with Hallden to install Farval on every machine it has built in the past 25 years. They believe this is the surest way to keep their machines functioning smoothly.

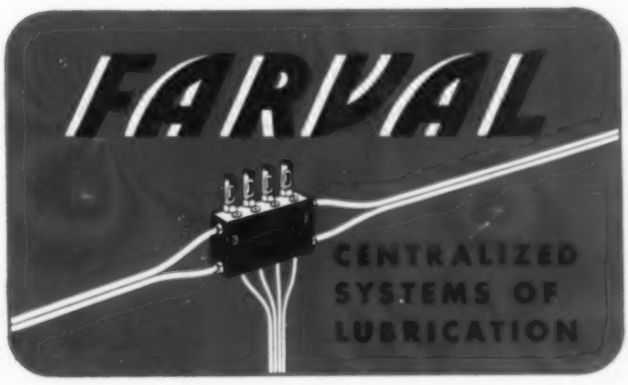
Farval accomplishes correct bearing lubrication while machines are in operation, without disturbing production schedules. Result: No slow downs, no breakdowns, no down time for repairs due to faulty oiling.

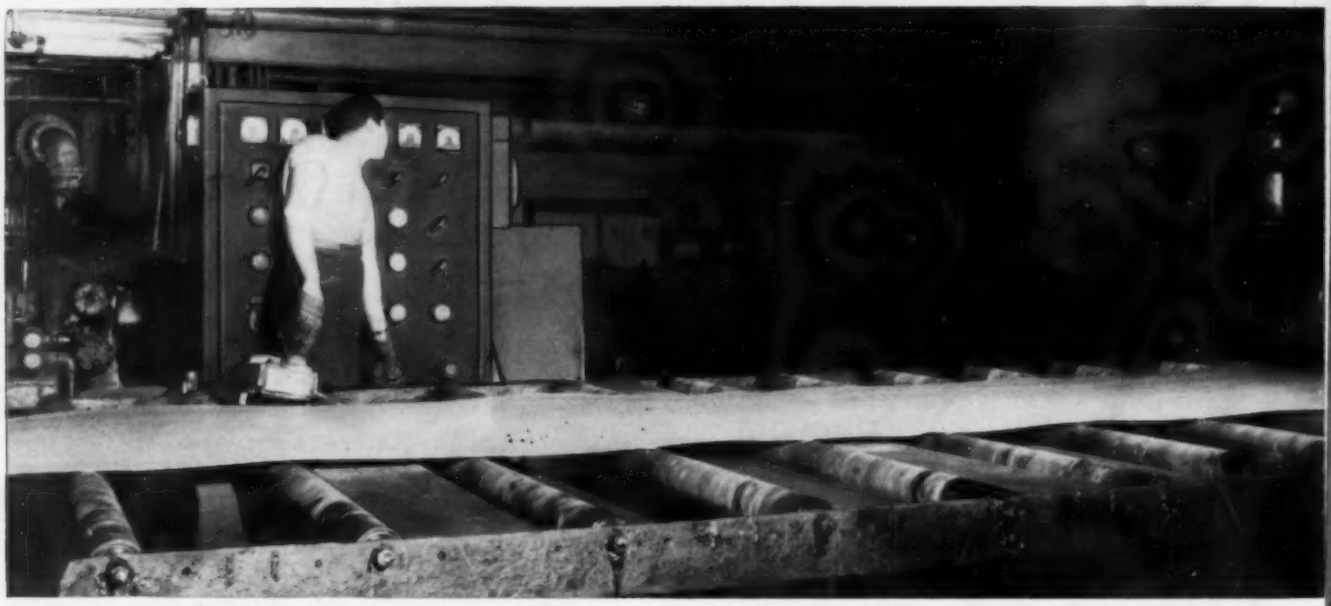
Farval is the original Dualine system of centralized lubrication for industrial equipment, proved practical in 25 years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, the Farval system unfailingly delivers oil or grease to each bearing—as much as you want, exactly measured—as often as desired. Indicators at all bearings show that each valve has functioned.

In or near your city there's a Farval engineer, ready to discuss your lubrication problems and suggest a proper system to meet your particular needs.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.





AT JONES & LAUGHLIN STEEL CORP. in Pittsburgh, G-E Magnetic Loop Control helps maintain pickling-line speeds up to 400 fpm. G-E control panel behind operator is for line in rear. Strip in foreground has just emerged from another G-E controlled line.

Strip tonnage raised by closer control of position, thickness, tension

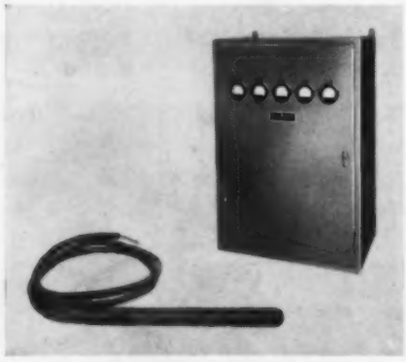
Faster pickling, more accurate tolerances, provided by special G-E products for steel mills

Pickling lines run at higher speeds when G-E Magnetic Loop Control keeps loop in proper position in the tank. Quick correction of deviations lets strip run at constant speed for more uniform pickling. Maintenance is cut by elimination of dancer rolls.

Hot or cold mill operators get strip on gage faster roll to closer tolerances, with a G-E X-Ray Thickness Gage. Noncontacting, it gives accurate, continuous indication at high strip speeds.

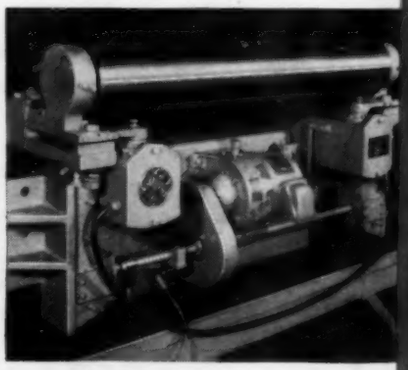
Less strip breakage, fewer cobbles result from accurate tension indication provided by G-E Tensiometer. Quick response enables use on tandem mills delivering strip at speeds up to 7000 fpm.

For more data on any of these products, see your G-E steel-mill representative or write for bulletins listed below to: General Electric, Sect., 687-85, Schenectady 5, N. Y.



G-E MAGNETIC LOOP CONTROL uses acid-proof pickup unit (l.), amplistat control unit (r.), and amplidyne to regulate speed of pinch rolls, maintain correct position of loop in tank. See Bulletin GEA-5618.

G-E X-Ray Thickness Gage measures thickness of fast-moving steel strip without contact. Top arm of 50-kv gage, shown above, contains detector; bottom tank contains x-ray tube. See Bulletin GEA-5622.



G-E Tensiometer, built from standard parts to fit special mill requirements, can be connected to tension-regulating circuits to regulate tension between stands automatically. See Bulletin GEA-5512.

GENERAL ELECTRIC

687-85